# POWER PLANT ENGINEERING

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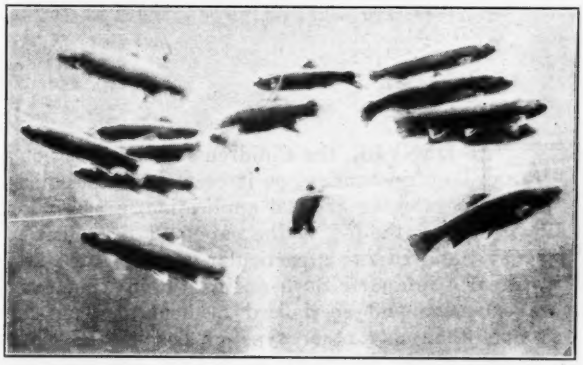

## Wotta Life! Wotta Life!

"WELL, IF THIS isn't a heck of a place for a young, unsophisticated brook trout to get thrown into!"

At this querulous remark, the venerable fish to whom it was addressed turned slowly to stare at the youngster who had dared disturb his meditations.

"What's the matter with it?" he rumbled in tones as deep as those of a salmon. "It's not so bad."

"Uh-huh," remarked the younger, "but what is this place anyway? I was swimming along in the hatchery with the boys when suddenly there was an earthquake or a tidal wave or something and I got sick and couldn't breathe and then I was dumped in here—kerflop! Well, sir, I started to swim right along out where it seems to be all clear, when bang! I bumped into something. Look at my nose! And the sun is so bright and there isn't any nice cool shadow under a rock and my nose hurts and I'm hungry!

"Ha! ha! ha!" boomed the old trout. "Why, you certainly are unsophisticated. For one thing, that isn't the sun; it's electric lights. And for another thing, what you bumped your nose on is glass. You don't need any cool shadow under a rock because the water is kept at exactly the right temperature, at enormous cost to the City of San Francisco, for each kind of fish in the Steinhart Aquarium and ——"

"Aquarium!" shrieked the youngster. "Oh, my sainted speckles! Ye Gods, me in an aquarium! Oh, why should I deserve such a fate!" and his wails and splashings filled the tank.

"Now, now, calm yourself" said his mentor, placidly. "It might be worse. You must cool down, because here comes our boss with some chopped liver and after dinner I'll tell you all about this place."

"Well, I'm awfully hungry," moaned the young trout, his grief somewhat assuaged. "But my nose still hurts. Wotta life! Wotta life!"


What the old trout told the young one after liver will be found on page 845 of this issue.

# Unique Boiler Plant Arrangement *for a* DENVER HOSPITAL

*by* DURBIN VAN LAW
Consulting Engineer, Denver, Colo.

AT DENVER, the Children's Hospital is not a large institution, as it occupies a specialized position in hospital application, its activities being limited to the care and treatment of children, with particular attention to those still in early infancy. Such an institution demands a more extensive and specialized medical and nursing personnel than any other type of hospital and also demands a degree of utility service not commonly required elsewhere.

The hospital, which now accommodates about one hundred thirty-five patients, is shortly to be expanded. A six-story Nurses' Home is to be constructed this year, to be followed by an additional story on the present hospital building, and this is to be followed shortly by entirely new hospital structure which will more than double the present patient capacity. The first step in this building program was the construction of a modern building containing a boiler plant, a refrigeration plant, machine shop, laundry and storage rooms for bedding and linen. All of these features are housed in a three-story brick structure located near the center of the hospital plot.

Particular interest centers in the boiler plant which contains unusual features. First and foremost, the feature of absolute cleanliness was a paramount issue. The fuel is coal of the sub-bituminous variety from the nearby fields of northern Colorado, low in heating value with plenty of dirt to be found in the screenings. This requires dust-proof containers and dust-proof conveying machinery. It also requires the isolation of coal handling and coal feed from the rest of the plant. A novel arrangement has made this possible.

Two Babcock & Wilcox longitudinal drum 1500-sq. ft. boilers were selected for unit setting. Each is equipped with a 48-sq. ft. Babcock & Wilcox forced draft chain grate stroker. Forced draft blowers were omitted, giving a divided compartment mechanism where combustion may be supported independently by induced draft on any or all of the three sections of the chain. This feature is desirable in the carrying of the lighter loads

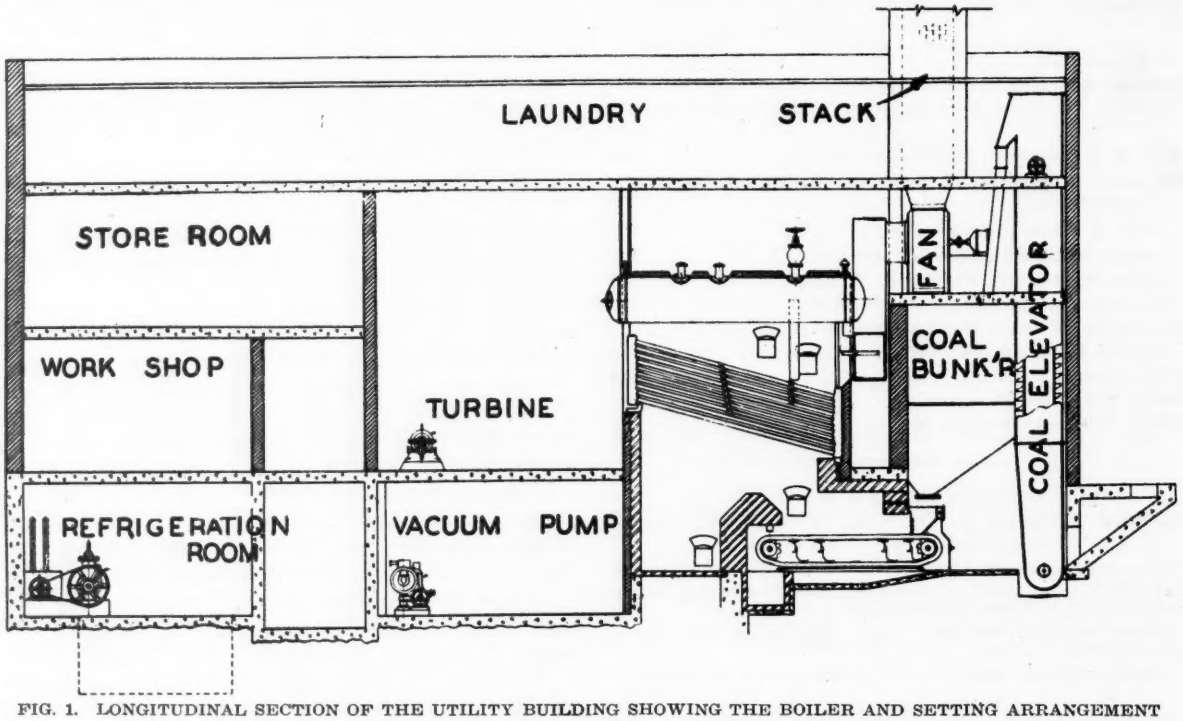


FIG. 1. LONGITUDINAL SECTION OF THE UTILITY BUILDING SHOWING THE BOILER AND SETTING ARRANGEMENT

imposed by the present hospital plant before the completion of the building program. The stokers are placed under an extension Dutch oven extending outward from the downtake boiler headers. Over two-thirds of the grate area is influenced by an internal combustion arch extending from the fuel grate well into the boiler.

Stoker hoppers and driving heads are in a separate room by themselves. Overhead are the coal bunkers, a separate one for each boiler. The bottoms are of riveted construction sheet steel and are supported from the building walls which rise above the steel work to provide storage capacity for sixty tons of coal. Referring to Fig. 1, a sectional elevation of the plant, it will be seen that the inside wall of the stoker room rises flush with the end of the extension furnace front, giving the appearance of stokers operating through a solid wall. Swing doors through this wall afford access from the aisle-way between the boilers, thus making the coal room approximately dust-tight and at least segregating the handling of coal from other portions of the plant. Note that the bunkers have no spouts; instead, a slotted gate the full width of the stoker is to be found at the low point of the bunker bottom discharging right into the stoker hopper. The space from bunker bottoms to hoppers is sealed with partitions, enabling the bunker gates to be kept wide open and affording the operator on the floor above an unrestricted view of the coal supply by means of a rear vision mirror mounted on the wall. Coal is elevated to the bunkers by means of a Jeffrey bucket elevator with distributing spouts from the discharge head.

### Dual Drive Generator Carries Emergency Lights

Complete, the boiler room proper occupies two floors with a connecting stairway between the two boilers. The basement floor houses all of the pumping apparatus, tanks, plant, switchboard and miscellaneous auxiliaries. The first floor is kept clear except for a small dual drive turbine set and a motor generator set which are used to furnish direct current for auxiliary drive. The dual drive turbine set, however, has a double mission. It consists of a Terry turbine of the impulse type connected to a 15-kw., 125-v., d.c. generator and a 25-hp. induction motor. In the winter, when considerable quantities of exhaust steam are required for heating, the induction motor is run as an induction generator, to supply a considerable proportion of the 3-phase current required elsewhere in the hospital. In summer, when little steam is required, the induction motor carries the load. A load-shifting device makes it possible to obtain an exact heat balance at all times. Finally, an automatic transfer switch on the main switchboard transfers certain selected lighting circuits from alternating current to direct current, and the turbine carries

FIG. 2. THE OPERATING ROOM, WITH THE TURBINE SET, OPERATOR'S DESK AND CONTROL BOARD

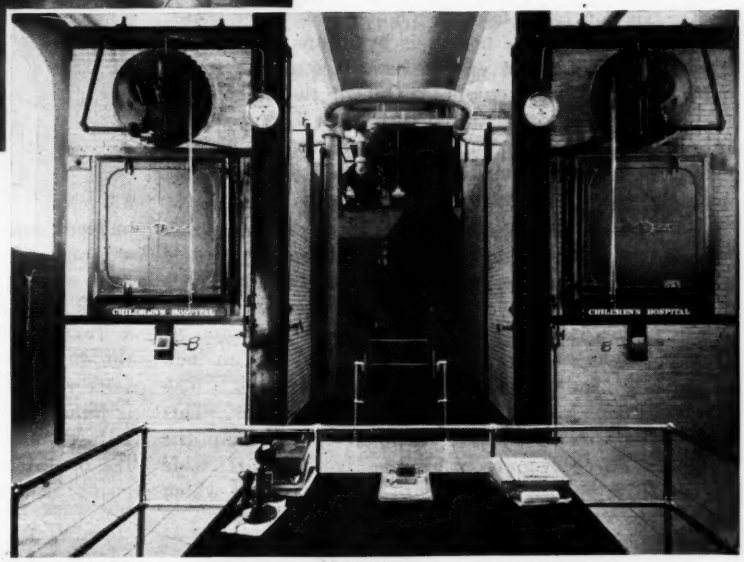


FIG. 3. VIEW FROM THE OPERATOR'S DESK. THE FURNACES CAN BE WATCHED THROUGH THE OBSERVATION DOORS B

FIG. 4. STOKERS ARE INSTALLED IN A SEPARATE ROOM AND ARE REMOTE CONTROLLED

the load in the event of an outage by the public service company. This obviates the necessity for storage battery equipment to protect the operating room and other vital points where even temporary darkness might cause loss of life. The turbine set is expected to pay for itself in less than a year.

Electric control is used throughout the boiler plant. Inducted draft for the boilers is by means of a motor-driven fan with direct current speed control. Stoker motors are for direct current. One of the boiler feed pumps is a triplex unit driven through a Texrope drive by a direct current motor. A remote control switchboard panel near the operator's desk affords full operating control of the entire plant.

Hospital cleanliness is a feature to be found in every point of the plant design. The boilers have a face setting of light-color, salt-glazed brick which matches the wainscoting of the room. This external brick facing is laid up against the boiler steel work and is insulated from the rest of the brick setting by an inch of air space and held together with metal ties. The operating floor is eight feet above the firing floor. This arrangement was deliberately chosen to break up the unsightly effect of narrow high-set boilers, 8 ft. wide and 24 ft. in height, as well as to isolate the dirt which

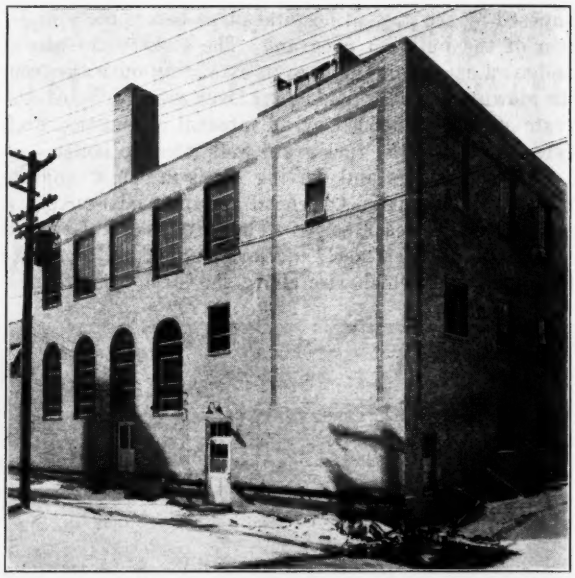

FIG. 6. THE BUILDING HAS BEEN DESIGNED AS AN ATTRACTIVE UNIT OF THE HOSPITAL

must occur at the firing front and at the ash doors. From this operating floor, the appearance is most pleasing; the settings are perfectly proportioned as to themselves and as to the room in which they are located. In an installation of this sort, appearance is indeed an item. Call it a frill if you like but certainly cleanliness never sacrificed efficiency.

### Operator Controls Plant

From his desk, the operator has entire control of his plant. The coal is overhead in bunkers served by a bucket elevator—the dust is confined. The coal cascades without attention into enclosed stoker hoppers. A remote control switch on the panel to the operator's rear starts the stoker motor, a rheostat adjusts the speed and a Texrope drive provides the feature of silence. On the fan balcony, the induced draft fan yields to the same type of control. The motorized triplex feed pump is handled from the same panel. Only infrequently to adjust the stoker coal gate and draw the ashes must the operator visit the floor below and enter the stoker room. The condition of his fire is observed through a

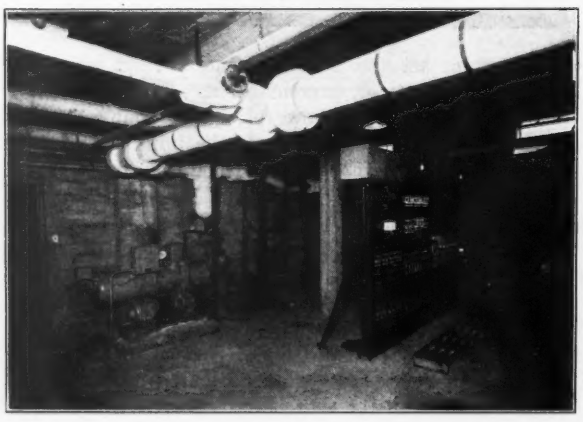

FIG. 5. THE VACUUM PUMP AND MAIN SWITCHBOARD ARE INSTALLED IN THE BASEMENT

FIG. 7. A GENERAL VIEW OF THE LAUNDRY ON THE TOP FLOOR

pyrex glass window in the end of the setting which affords full visibility from the operating floor.

In order to insure high efficiency, a high, narrow boiler setting with a flexible grate area to suit the degree of loading; close draft regulation; feed pump speed variable over wide limits and finally, a nearly perfect heat balance by means of turbine regulation have been incorporated. Sufficient steam is admitted to satisfy (within the limits of the machine) domestic heating requirements, domestic hot water requirements and steam requirements for heating boiler feed. When these requirements are at a maximum, the machine runs at full capacity, generates the necessary direct current for plant operation and feeds alternating current back into the line for use elsewhere in the hospital. As these requirements for exhaust steam diminish, the load is shifted over to the motor for the public service company to carry in full or in part.

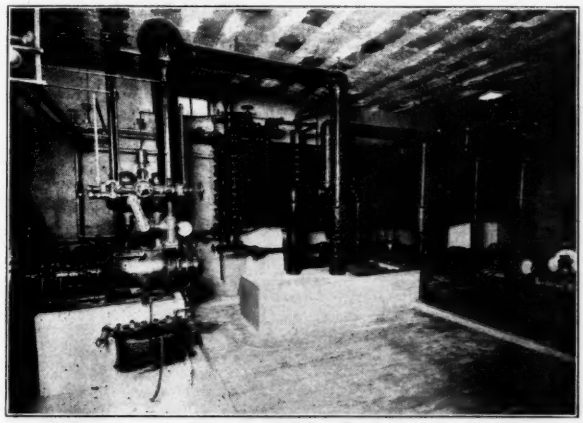

FIG. 8. COMPRESSOR THAT TAKES CARE OF THE REFRIGERATION LOAD

No steam escapes to the atmosphere. The turbine unit is small, purposely selected so, for the small isolated plant can seldom afford to generate all of its own current. But in this instance at least, convenience made necessary a piece of apparatus which is proving exceedingly profitable in a small way. It provides direct current for plant control, it supplies emergency current for selected circuits when the regular source of current fails and it generates an average of seven thousand kilowatt-hours of alternating current per month abating the hospital's consumption by that amount at a substantial saving for both demand and energy charges.

Overhead is the hospital laundry, modern in its machinery and design. The laundry floor is supported from the prolonged boiler columns. The whole project in fact, is closely correlated and furnishes a clear example of building construction designed to conform to the requirements of specific machinery and apparatus.

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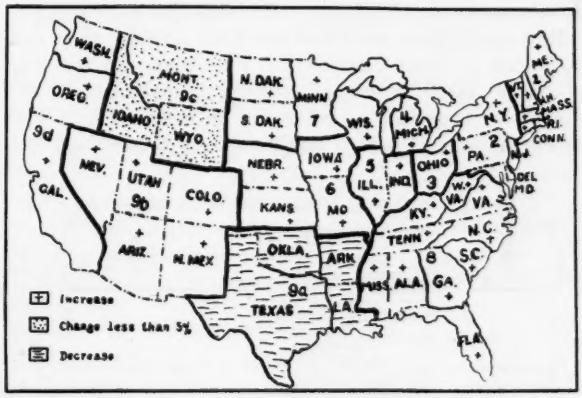
FRAMEWORK of the Research Bldg. now under construction at Niagara Falls by the Union Carbide Co. is being fabricated and erected entirely by oxy-acetylene welding. It is 75 ft. by 260 ft. and requires 300 t. of steel. Design and fabrication have been by the American Bridge Co. assisted by the Engineering Department of Linde Air Products Co. which also supervises the field welding.

# New Bureau of Mines Service Analyzes Coal Consumption

BUREAU OF MINES, Department of Commerce, in collaboration with other agencies, has begun a new statistical service showing the trend of coal consumption in the principal markets. The service will supplement the statistics of production and consumers' stock already published by the bureau. It is intended to




MAP SHOWING CONSUMPTION OF COAL BY ELECTRIC POWER UTILITIES IN JANUARY, 1929, COMPARED WITH THAT IN JANUARY, 1928

facilitate the distribution of coal by indicating the sections of the country and the industries where consumption is increasing or, on the other hand, those where it is decreasing. The report will be supplied on application to the Chief, Economics Branch, Bureau of Mines. The nature of the service is illustrated by the accompanying table analyzing the coal consumption of the electric public utility power plants as reported by the United States Geological Survey. The chart shows

TABLE ANALYZING COAL CONSUMPTION BY ELECTRIC PUBLIC UTILITIES IN UNITED STATES

| District | Number of plants reporting | Net tons consumed Jan.1928 | Net tons consumed Jan.1929 | Increase or decrease Net tons | Increase or decrease Per cent |
|---|---|---|---|---|---|
| 1. New England | 62 | 227,695 | 303,924 | + 76,229 | + 33.5 |
| 2. Middle Atlantic | 150 | 1,234,996 | 1,330,110 | + 95,114 | + 7.7 |
| 3. Ohio | 85 | 363,270 | 425,495 | + 62,225 | + 17.1 |
| 4. Southern Michigan | 37 | 191,491 | 226,741 | + 35,250 | + 18.4 |
| 5. Illinois-Indiana | 116 | 735,343 | 816,464 | + 81,121 | + 11.0 |
| 6. Lower Missouri Valley | 164 | 247,463 | 262,620 | + 15,157 | + 6.1 |
| 7. Lake Dock Territory | 117 | 164,092 | 184,296 | + 20,204 | + 12.3 |
| 8. Southeast | 158 | 358,451 | 383,387 | + 24,936 | + 7.0 |
| 9a. Southwest | | 124,830 | 112,058 | - 12,772 | - 10.2 |
| 9c. Northern Rocky Mountain | 97 | 11,369 | 11,848 | + 479 | + 4.2 |
| 9b&d.So.Rocky Mt.& Pacific | | 36,236 | 63,320 | + 27,084 | + 74.7 |
| | 986 | 3,695,236 | 4,120,263 | +425,027 | + 11.5 |

the same information in another form. In all but two of the districts, there was a substantial increase in consumption in January, 1929, as compared with the same month of 1928, the average increase being 5 per cent. Further details of fuel consumption and power production in each state are given in a report compiled by A. H. Horton, which may also be had on application to the Director, U. S. Geological Survey.

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GOOD BITUMINOUS COAL at $6.50 a ton costs about the same per million B.t.u. as wood at $7.00 a cord and about as much as natural gas at $1.20 per thousand cubic feet, anthracite coal at $15 per ton, coke at $12.00 per ton, or fuel oil at 7c per gal.

# A Symposium on Couplings for Turbine Units

BEARING ALINEMENT AND EXPANSION DEMANDS OF LARGE MACHINES MAKE FLEXIBLE COUPLINGS BETWEEN TURBINE UNITS AND BETWEEN TURBINE AND GENERATOR ALMOST UNIVERSAL PRACTICE. BY O. JUNGGREN, W. ROTH, J. D. SCHMIDT AND J. WILSON

IN ORDER TO FACILITATE manufacturing and maintenance, practically all shafts for both reciprocating and rotary machines are built so that they can be joined to other machines by couplings. In the case of some small types of electrical machines, it is sometimes practical to build the elements of both the prime mover and driven machines on a single shaft but

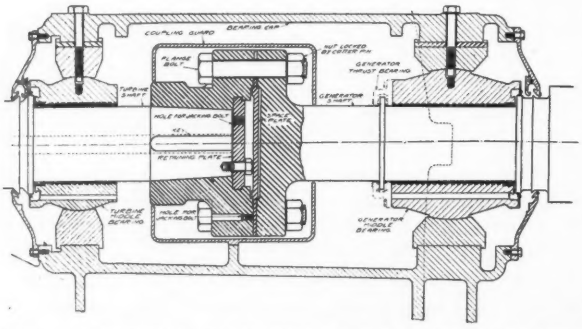

FIG. 1. SECTIONAL DRAWING OF A SOLID COUPLING AND MIDDLE BEARINGS OF A GENERAL ELECTRIC FOUR BEARING MACHINE

for other equipment, the shaft, whether it be a crankshaft for an engine, a spindle for a turbine or a rotor for a piece of electrical equipment, is built as a unit with a suitable coupling for attachment to other machines.

In addition to making the handling of the piece easier during actual manufacture, this practice tends toward simplified design as the same motor, engine or turbine can be utilized for driving a pump, a generator, gears or other machine. It is also of assistance to the user, as it allows either the prime mover or driven machine to be changed at a minimum expense.

Sometimes the couplings between the machines are made rigid; that, is, each half of the coupling is accurately machined and fitted together so that the several portions of the shaft act as a single shaft. In other cases, the ends of the shafts are joined together so that more or less relative movement can take place between the different shafts. A coupling of this type is known as a flexible coupling.

Rigid couplings are advantageous in allowing a three-bearing construction; that is, an outboard bearing on each machine and a common bearing which serves both machines between the two. Such three-bearing construction is not particularly adapted to manufacturing methods where all machines are turned out as a unit and, in this country at least, the so-called four-bearing machine is more popular. In this construction, both the prime mover and driven machines are equipped with two bearings.

When joined together, often on a common bedplate, by a coupling, the unit has four bearings. Proper alinement of four bearings is much more difficult than the alinement of three bearings and flexible couplings are commonly employed, although there is no reason why solid couplings could not be used if the expense and trouble of alining the four bearings were thought advisable. As the number of bearings increases beyond four, exact alinement becomes almost impossible.

With small and medium-sized machines, many types of flexible couplings are available. For larger machines in the neighborhood of 10,000 to 20,000 hp., the number of suitable designs is rather limited if excessive size is to be avoided.

With steam turbine-driven generators ranging from 20,000 to 100,000 kw. driven through a single shaft, the

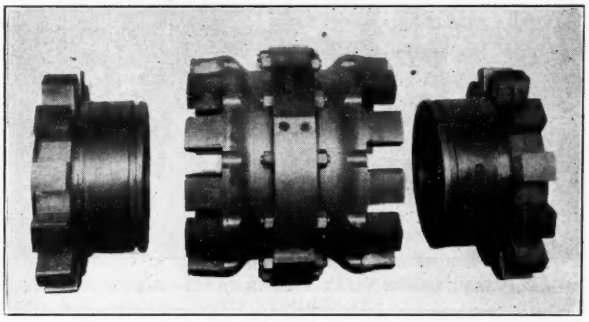

FIG. 2. FLEXIBLE JAW COUPLINGS AS USED ON GENERAL ELECTRIC TURBINE UNITS

problem of design becomes of some importance. With multi-cylinder turbine designs, the problem becomes of greater importance because the problem of alinement of bearings between each element be considered and the thermal expansion of the spindle must be taken care of as well.

That this problem has successfully been solved by all the manufacturers of large turbines is borne out by the small amount of trouble experienced with turbine couplings. In order to familiarize our readers with the standard practice of large turbine manufacturers in this country and the relative advantages of both flexible and rigid couplings, we have arranged a symposium which we feel will be of service to the industry.

O. JUNGGREN
*Consulting Engineer, Turbine Dept.,*
GENERAL ELECTRIC CO.,
Schenectady, N. Y.

THE QUESTION of whether a solid or flexible coupling should be used between the turbine rotor and the generator and in the tandem units between the turbine elements, depends a great deal upon the design and there is no hard and fast rule for it.

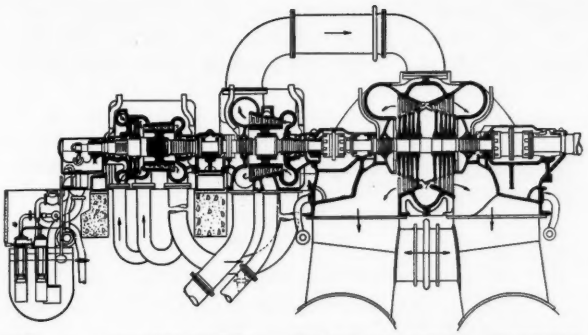

FIG. 3. BROWN-BOVERI THREE-CYLINDER TURBINE SHOWING LOCATION OF COUPLINGS ON THEIR MULTI-CYLINDER MACHINES

When flexible couplings are properly designed they can be made to carry practically any load that can be developed, so if there is in any case failure of flexible couplings, it is not generally due to their flexibility, it is mostly due to faulty design. There is no standard practice in America for using solid couplings, but in many cases flexible couplings are used where solid couplings would have done equally well, being simpler, and having no wearing elements.

When we come to turbine constructions having two or three casings, flexible couplings are necessary in order to hold the various turbine elements in their place and also to satisfy expansion. In this case, no solid coupling has as yet been proposed that will satisfy this condition.

W. ROTH
AMERICAN BROWN BOVERI CO., INC.,
Camden, N. J.

STANDARD PRACTICE of this company can be shown by means of Fig. 3, a section of a large multi-cylinder machine. The turbine consists of three cylinders: high pressure, medium pressure and low pressure. The design and arrangement of the high-pressure and intermediate-pressure cylinders is such that their rotors balance the axial thrust of each other. They are connected rigidly by means of two forged flanges bolted together and a thrust bearing is provided between the two cylinders for taking care of small axial unbalance at certain loads.

The low-pressure turbine is of the double flow arrangement and therefore balances itself. A thrust bearing is provided on one side and it is obvious that the

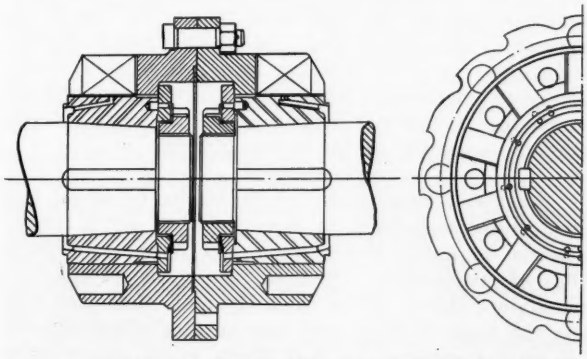

FIG. 4. STANDARD FLEXIBLE CLAW COUPLING AS USED BY BROWN-BOVERI FOR ALL LARGE UNITS

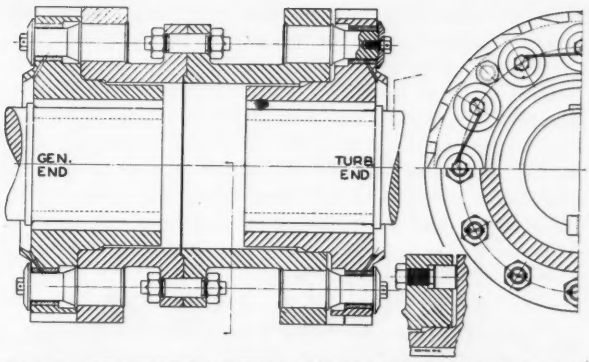


FIG. 5. PIN TYPE FLEXIBLE COUPLINGS USED ON WESTINGHOUSE UNITS UP TO 20,000 KW., 1800 R.P.M.

connection between the rotor of the low-pressure turbine and the other two rotors must be flexible. Brown Boveri uses for such purposes a type of coupling, shown in Fig. 4, similar to the so-called Parsons Coupling. This coupling allows for a certain axial clearance and also small misalinements of the component axis in case this should happen.

J. D. SCHMIDT
*Large Turbine Engineering Dept.*,
WESTINGHOUSE ELEC. & MFG. CO.,
Philadelphia, Pa.

IT IS OUR UNDERSTANDING that the prevalent practice in Europe is to use rigid couplings between the turbines and generators of four-bearing units and between the turbine elements of tandem-compound units. American practice, on the contrary, dictates the use of flexible couplings in almost all cases involving four-bearing machines. Three-bearing units have, of course, been quite commonly built with rigid couplings between the turbines and generators.

It has generally been considered that the use of a rigid coupling between two rotating elements, each of which is carried in two bearings, involves too great a risk of concentration of load upon one bearing as a result of slight misalinement between the elements. The possible ill-effects of such load concentration have been

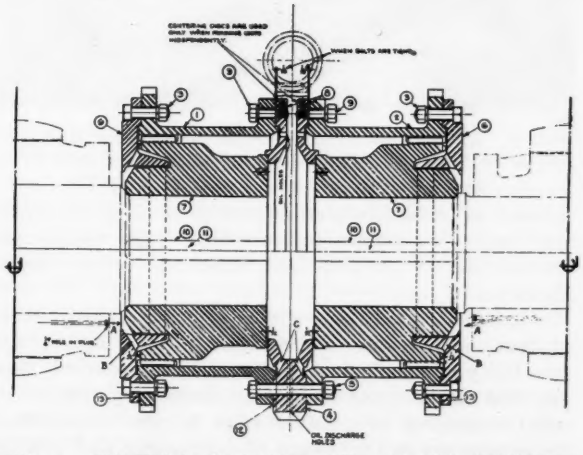

FIG. 6. FLEXIBLE COUPLING USED BY WESTINGHOUSE FOR LARGER 1800-R.P.M. TURBINES. THIS COUPLING IS EQUIPPED WITH A MOTOR-OPERATED TURNING GEAR

deemed much more serious than the maintenance expense associated with the use of flexible couplings.

The Westinghouse Electrical & Mfg. Co. has employed and continues to employ, a flexible coupling of the pin type, Fig. 5, in units of up to about 20,000 kw. In larger applications, the type of coupling, Fig. 6, has in recent years been adopted as standard. Our experience with both of these types has been highly satisfactory and there have been practically no cases of

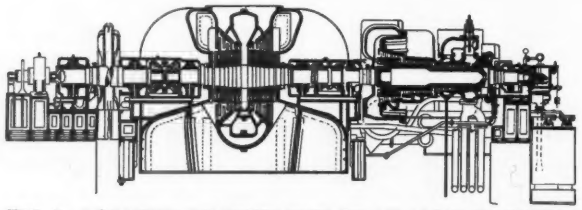

FIG. 7. LOCATION OF COUPLINGS ON AN ALLIS-CHALMERS 50,000-KW. TANDEM COMPOUND TURBINE UNIT

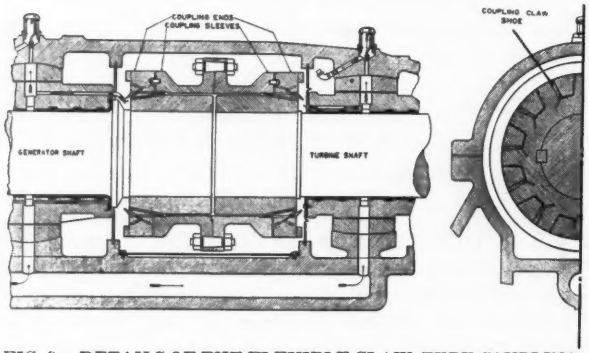


FIG. 8. DETAILS OF THE FLEXIBLE CLAW-TYPE COUPLING SHOWN IN FIG. 7

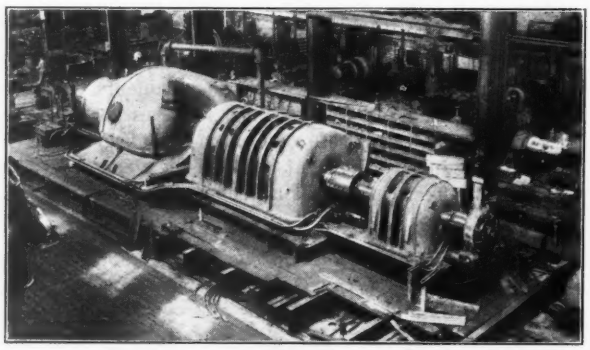

FIG. 9. EXTERNAL APPEARANCE OF FLEXIBLE COUPLINGS AS USED ON AN ALLIS-CHALMERS 20,000-KW. UNIT

failure, of unsatisfactory operation or even of excessive wear. We believe our experience to be representative of that of the principal American turbine manufacturers.

Satisfactory past experience notwithstanding, it is obvious that, because of the nature of the coupling, the possibility of wear exists, and it is equally obvious that any one of the types of flexible coupling is inherently more expensive to produce than a rigid connection. Improvements in the means of supporting and alining turbine-generator parts and the continually increasing knowledge of the action of foundations and apparatus under change of temperature, seem to indicate some likelihood that a transition from the present American practice to the European system may take place. That this is not unlikely is indicated by the fact that, recently, some installations have been made in the United States in which rigid couplings are employed in four-bearing units and additional similar applicatons are contemplated.

J. WILSON
*Steam Turbine Department,*
ALLIS-CHALMERS MFG. CO.,
Milwaukee, Wis.

ALL OF THE large steam turbine builders in this country build turbo-generator units with the generator connected to the turbine by means of a flexible coupling. Figure 7 is a section through an Allis-Chalmers 50,000-kw. unit. This unit is a tandem cylinder, single generator machine and a flexible coupling is provided between the high-pressure and low-pressure turbine shafts and also between the low-pressure turbine shaft and generator shaft. The exciter armature is also connected to the main generator shaft by means of a flexible pin type coupling.

Figure 9 is a photograph of a 20,000-kw., 1800-r.p.m. Allis-Chalmers unit which is provided with a house generator driven by the main steam turbine. A flexible coupling is provided between the turbine and generator and another flexible coupling is provided between the main generator and house generator. In this case, the exciter armature is formed on a prolongation of the house generator shaft, therefore no coupling is necessary at this point. Figure 8 is a section of this company's claw-type flexible coupling.

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TWO BOOKS have just been issued covering the story and plans of Light's Golden Jubilee. The official Jubilee Book issued by Light's Golden Jubilee Committee, 420 Lexington Ave., New York, tells the story of the Jubilee, the nature of this tribute to Edison, its inception and how it is to be carried out. It is the official story of the Jubilee, released by the general committee of which President Hoover is honorary chairman. It contains information about Mr. Edison and his work and should prove useful for distribution in communities planning to take part in the celebration. It should be ordered from the Committee. The second publication, issued by the N. E. L. A., 420 Lexington Ave., New York City, contains suggestions for local participation in the world-wide tribute to Thomas A. Edison. This is a 44-page book with colored illustrations and gives suggestions for local committees in carrying out their celebration. It should be ordered from the Commercial Section of the National Electric Light Association at the above address.

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IMPROPER COMBUSTION which results in smoke and soot causes losses from two sources. First, soot is largely carbon or heavy hydrocarbon and means the direct loss of combustibles. Second, soot is one of the best insulators known and a thick layer of sticky soft soot on the boiler surface puts that surface effectively out of service, causing the heat which would otherwise be absorbed to pass out with the flue gas.

# Properties *and* Tests *of* CARBON BRUSHES For Motors *and* Generators*

**G. M. LITTLE,** *Research Engineer*
Westinghouse Electric & Mfg. Co.

CARBON BRUSHES, which form a sliding contact with the commutator of a generator or motor, have an importance all out of proportion to their cost. An expensive machine may fail to operate and even be destroyed if it is not equipped with brushes suited to its needs. In order to devise improved methods of brush testing, to correlate some of the brush properties with the performance of brushes in different kinds of field service and to improve the quality of the brushes manufactured for different services, an extensive research was instituted.

Usual brush manufacture can be outlined as follows: a properly proportioned mixture of powdered coke, lampblack, charcoal and graphite, together with hot coal tar pitch is prepared. This is heated, mixed thoroughly, allowed to cool and ground to a flour. The flour is put in strong steel molds, heated and pressed into plates under hydraulic pressure. The plates are packed in sand and baked for a week or so at about 1200 deg. C. This completes the firing for many grades, but others are given a second bake in a graphitizing furnace. In this furnace, the temperature is so high that iron is volatilized and driven out, and coke is converted into graphite.

Manufacture of brushes bonded with synthetic resin (bakelite, durite, etc.) is an exception to the usual process of brush manufacture. The powdered coke, graphite, etc., are mixed with the correct amount of synthetic resin and solvent. This is stirred, heated, allowed to cool, powdered, pressed hot into plate form and cured at a moderate temperature. The plates are not baked at 1200 deg. C. as in ordinary practice and are never put through the graphitizing furnace.

The skill of the carbon manufacturer is shown in the degree of control he has over the properties of the finished brushes. The apparent density of a carbon brush may be lowered by using coarser flour, less pitch, lower molding pressure, lower molding temperatures, etc. The real density may be raised, for instance, by increasing the temperatures of the graphitizing furnace. The abrasiveness of the finished brush is almost entirely dependent on the presence of materials other than carbon and the amounts of these materials in the brush may be varied by the addition of certain natural graphites which contain a high percentage of iron, alumina, and silica.

The heat flow test is a quick method of determining the thermal conductivity of brushes but, as the results do not depend solely upon the thermal conductivity, the term heat flow has been coined. The test shows how rapidly a brush, at room temperature, will conduct heat away from a small piece of hot copper which has been placed in firm contact with it. The results depend chiefly on the thermal conductivity of the brush and on the thermal conductivity of the contact film between the copper and the carbon.

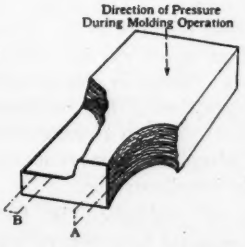


FIG. 1. LAMINATED STRUCTURE OF A CARBON BRUSH SHOWING WHY THE BRUSH BREAKS SMOOTHLY IN THE B PLANE BUT WITH DIFFICULTY IN THE A PLANE

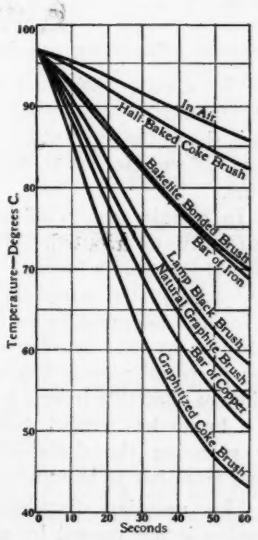


FIG. 2. HEAT FLOW CURVES OF SEVERAL DIFFERENT TYPES OF BRUSH

Figure 2 shows the wide range of results found between different kinds of brushes, which check closely on retrial. In a general way, the values vary with the electrical resistance of the brushes. One surprising result is that some grades of brushes take heat away from the small piece of copper faster than will a large bar of pure copper. This indicates that the thermal conductivity of the copper-carbon contact film is higher than that of the copper-copper contact film.

An air flow porosity test was designed primarily as a quick method for determining the porosity of the brush, by determining how rapidly a certain volume of air under a uniform pressure or suction will pass through the pores of a specified area of brush surface.

*Based on a paper read before the Pittsburgh Section of the A. I. & S. E. E

The test does not give any indication of the per cent of space occupied by the pores, but it does show whether the pores are connected together or whether they exist as more or less isolated cavities. One brush may contain five times as great a pore space as another, yet the air-flow test may show a much slower passage of air.

There is a wide range of results; some brushes are almost like a sieve, the air passing through in one second while other brushes require as high as 500 seconds. The test, on repetition, checks well and does not injure the brush.

This test gives a good indication of brush uniformity and has other possibilities in that it may show the ability of a brush to free itself from the layer of air which is trapped between a brush and a commutator face, and which may prevent a good electrical contact with the commutator. The presence of this trapped film of air is readily shown in the case of non-porous metal-graphite slip ring brushes, by drilling a hole down through the center of the brush and connecting it to a manometer gage. Often a pressure of over eight inches of water is found, though sometimes a partial vacuum exists.

### Determining Brush Resistance

The specific resistance of a brush is determined by the standard method used for other conducting solids. As it shows the current carrying capacity and furnishes some information as to the contact drop, it is of great value.

In certain grades of brushes, the resistance is not uniformly distributed. This is particularly true of some of the grades bonded with a synthetic resin. These have a laminated structure, as shown in Fig. 1, and the resistance measured in a direction parallel to the layers is apt to be only one-fourth that measured in a direction perpendicular to the layers. There is considerable evidence that this irregular disposition of the resistance in a brush has a most desirable effect on commutation by reducing the destructive circulating current that flows from bar to bar under the brush surface.

The peculiar distribution of resistance in these brushes is not caused by any manual layering process, but occurs naturally in mixtures of this kind when they are subjected, while in a plastic condition, to pressure in one direction. When, in the molding process, the plunger descends on the soft mass, the particles of which it is composed turn in such a way that their shortest dimension is in the direction of the pressure, and a distinctly laminated structure appears. A brush of this kind may be split much more readily in the direction of the layers than in the cross-section.

The method used at most carbon works for the measurement of strength is to determine the weight, applied at the middle, necessary to break a sample bar of uniform cross-section, when supported on knife edges placed a standard distance apart. This test is sufficiently accurate, but it does not show the cumulative effect of repeated blows such as a brush is subjected to in traction service. Furthermore, this test is not applicable to small samples. To overcome these defects, an impact testing apparatus was devised. This consists of a miniature pile driver in which a sliding weight strikes a sharp blow on a ⅜-in. cube cut from a brush. The number of blows required to break the sample is taken as a measure of brush strength. The correctness of this was verified by the fact that the brushes that broke in service would break most readily in the impact tester.

As most of the trouble in service occurred in cold weather, it was thought that perhaps heat, cold, or moisture were the causes. Tests were made to determine the effects of different conditions on the breaking strength, but an examination of new brushes taken from a shipping box and which had never been in service showed variations in strength from brush to brush much greater than the variations produced by temperature and moisture treatments.

It then becomes necessary to devise some way by which brushes direct from makers could be tested for strength and yet not be injured. An examination of new brushes disclosed the fact that they differed from each other in the pitch of the sound that was given out when the brushes, supported on a cloth pad, were struck on a corner with a wooden rod. High-pitch and low-pitch samples were selected from these new brushes. Samples were cut from them and given the impact test, and a direct relation was established between the tone pitch and the number of blows required to break the sample. Brushes that gave out a tone having a pitch below G on the musical scale were rejected, thus stopping the breakage in service.

This test requires a musical ear and considerable trouble was experienced in obtaining men for the work. To an on-looker, this test has much in common with the xylophone of an orchestra, in fact, a carbon-brush xylophone has been built on which tunes can be played.

There is a wide variation in pore space to be found in brushes of different grades. It varies from 10 per cent in a compact, fine grained brush, to 45 per cent in an open-grained, soft, coarse-textured variety. This is determined by dividing the difference between the real and the apparent density by the real density. Some grades absorb air; that is, condense, possibly in a liquid form, a considerable amount of air on the surface of the carbon particles. This is readily shown by exhausting and measuring the air from a brush sample of known volume. In some cases an amount of air of considerably greater volume than the sample itself is obtained.

### Chemical Properties

All brushes contain materials other than carbon. These materials produce pronounced effects on the performance of the brush, the most notable being a scouring or abrasive action on the surface of the commutator. The quantity and character of the abrasive material is determined by igniting a sample brush and examining the ash.

Usually the ash is colored, varying in shade and tint from pure white to pink, yellowish red, brown and black. A white ash, as a rule, shows that a brush has been thoroughly graphitized. It has been heated so hot that the iron, which is the most frequent cause of pink, red or brown color, is volatilized and driven out. Such a brush is usually non-abrasive. A red or brown ash contains much iron and, as a rule, indicates a brush which is abrasive. A black ash usually indicates copper, although it may be unburned carbon that will disappear on further heating.

It is found that the presence of so little as a tenth of one per cent of certain impurities will make a profound difference in the behavior of a brush. Some materials seem to cause a change in the character of the minute arcs which frequently exist between the brush face and the rapidly moving commutator.

It is necessary that some current shall flow in order to bring into play the abrasive cutting action. An abrasive brush may be run without current on a commutator for months with scarcely any wearing action but, when the brush carries current, the cutting of the commutator commences. It appears that there is something more than straight mechanical abrasion here; possibly an electrolytic action.

Presence of measurable amounts of ash in a brush may also be shown by an x-ray examination. Carbon is transparent to the x-rays while the ash materials are for the most part opaque, so that a brush containing a high percentage of ash throws a noticeably darker shadow.

This volatile-matter test is used more in the preliminary examinations of the materials from which the brushes are made, but some information may be obtained by its use in the examination of certain grades of finished brushes. Thus the presence of notable amounts of volatile matter in a synthetic resin-bonded brush shows that it has not been cured sufficiently. A volatile-matter test of doped (paraffined) brushes gives an indication as to how much of the dope is present. This test is conducted just as volatile matter in coal is determined. A weighed sample is heated to bright redness in a covered crucible. The loss in weight is the volatile matter.

### Operating Characteristics

Contact drop is a measure of the number of volts required to force a given current across the contact between a brush and the surface of the commutator. It is the chief distinguishing feature which enables carbon brushes to commutate well, where metal brushes fail. The contact drop of carbon brushes is several times that of copper brushes and is useful in preventing a large circulating current-flow, and hence a large spark when the adjacent bars of a commutator are connected by the brush.

Contact drop is determined on a special apparatus which consists of a horizontally rotating copper disc or wheel. The brush sample is forced down on the disc surface by a weight. A constant direct current is sent from the plate to the brush. After a preliminary run of 24 hr., readings are taken for several days with a voltmeter whose terminals make contact with the plate and the brush and the contact drop obtained by averaging these results.

There is a general belief that, if the coefficient of friction is high, there must be a decided wearing and abrasion of the surface of the commutator. The evidence, as shown by tests, is decidedly to the contrary.

The coefficient of friction is determined at the same time as the contact drop, by means of an adjustable sliding weight on a rocker arm. The rocker arm is attached to the brushholder so that it measures the horizontal drag or pull of the brush. The horizontal pull, divided by the vertical pressure is the coefficient of friction. These two tests, the contact drop and the coefficient of friction, are accurate and reproducible under laboratory conditions, but it is likely that, under the different conditions existing in practice, radically different results will be obtained.

A great many samples have been tested on this machine and only a fair agreement is found to exist between the results and the actual behavior of the brushes in service. Contrary to what one would expect, a brush that will score and scrape the surface of the plate may have a much lower coefficient of friction and a lower contact drop than another non-abrasive brush which gives a very high polish, but which seems to adhere to the surface of the plate. This may be the same effect as the well-known sticking together of two metal plates whose surfaces are very flat and true.

Brushes may fail in a number of different ways. For example, they may be short lived, they may break, chip, expand and stick in the holders, disintegrate and form dust, or show excessive side wear, or they may act on the surface of the commutator in such manner as to cause high mica, burnt bars, smutty surface, ring fire, packed slots, flats, grooves, high temperatures, noise, sparking, etc.

The condition of the machine means a great deal in a test of this kind. The bearings may be worn, the commutator out of true, the commutator oily, the armature unbalanced or the mica poorly undercut; or the machine may operate where there is dust or fumes, the spring-pressure may be too high or too low, etc. The foregoing and other conditions should be watched and avoided, as a brush failure does not mean much unless the conditions are known.

When a brush is commutating well, there may be no sparking, or if there is any sparking at all it will occur uniformly around the commutator. It is interesting to watch, with the rotoscope, a rotating commutator on which a group of bars has become burned. The sparking is seen to occur only when the burned bars are under the brushes; the rest of the commutator may be operating perfectly and show no sparks.

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Westinghouse Electric & Manufacturing Co. announces the securing of a large power line communication order from the Southwestern Gas & Electric Co. This order covers 5 high-power, 250-watt sets which will be installed at Shreveport, La.; Marshall and Mineola, Texas; and Texarkana and Saratoga, Ark. A total of approximately 500 mi. of power lines between those points will be used for communication purposes as well as for the transmission of power. To insure continuity of service past those points where the power lines are opened at certain times or where there are transformer banks, four bypass equipments will be supplied. Another feature of the installation will be the use of tuned resonant line chokes, the use of which gives clear, isolated power line communication channels on the most complex power networks. The system when installed contemplates inter-communication with the power line communication equipment on the Arkansas Power and Light Co. system.

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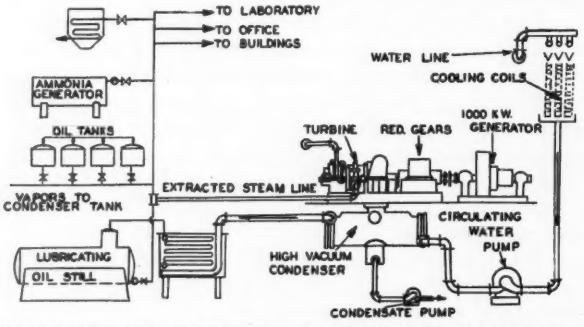
Standby exciter sets should always be selected so that they can be paralleled with the regular excited units and should be designed primarily for reliability. Steam-driven machines are usually favored for industrial plants or isolated central stations.

# Using Condenser Cooling Water Three Times

OIL REFINERY USES SAME WATER FOR WAX PLANT, SURFACE CONDENSER AND OIL STILLS. PLANT PRODUCES A KILOWATT-HOUR ON 9.4 LB. OF STEAM

SOME TIME ago it became necessary for the Pure Oil Co. to provide additional electrical generating equipment in its Marcus Hook refinery. According to the Pure Oil News, an Elliott 1460-hp., 3600-r.p.m. extraction turbine driving a 1000-kw., 250-v., d.c. generator through herringbone gears was installed. This turbine is set over a 2240-sq. ft. surface condenser with divided water box, a two-stage steam ejector, a 1500-g.p.m. motor-driven circulating pump and two 50-g.p.m. condensate pumps are motor and turbine driven.

Steam entering the turbine at 145 lb. gage, 150 deg. F. superheat is bled at 25 lb. between the fourth and fifth stages of the 12-stage turbine. Steam not extracted expands through the turbine to the condenser.




DIAGRAMMATIC ARRANGEMENT OF MARCUS HOOK PLANT WHERE WATER IS USED THREE TIMES

Accurate records of the steam over a period of a year show that for an average of 10,876 lb. per hr. supplied to the turbine 7200 lb. per hr. was extracted, equivalent in heat value to 6718 lb. of high-pressure steam.

The quantity of steam chargeable to the turbine is the difference between this last value and the total high-pressure steam or 4158 lb. per hr. The average load was 442 kw., which means that the plant produced a kilowatt-hour on 9.4 lb. of steam.

Extracted steam is used for a variety of purposes as indicated in the drawing. Part of it is used in connection with lubricating oil distillation in the shell still battery that is not far from the power house. In winter time a considerable quantity is required to maintain oil temperature in storage tanks around the wax plant. These tanks contain such commodities as wax distillate, finished lubricating oils and fuel oil, all of which must be kept fairly warm in order to facilitate pumpage. Probably the largest part of extracted steam over a year's period goes to the ammonia generators of the two 100-t. Carbondale absorption type refrigerating plants. The consumption of these machines being fairly constant, is ideal for such a system. The new Sweetland filter contact plant also uses this steam to heat up the oil to proper contacting temperature. Another line out of the 25-lb. system leads to the new office and laboratory where it is used for heating and other general purposes. Several other buildings receive their heat out of the same system in winter.

It will be noted that the average electric load is slightly less than half of the generator rating; however, the power plant is called upon to meet the high demand that is occasioned when tankers discharge their cargoes of crude oil, since at that time it is necessary for two large pumps, each equipped with a 200-hp. motor, to deliver crude oil to the Hance Tank Farm 4 mi. distant. During these periods, which occur approximately every 10 days, the peak loads run up as high as 850 kw. The load will also increase somewhat on account of the installation of the new equipment.

Because of the great distance between the power house and the river, the cost of providing the condenser with the large quantity of water necessary would be quite high if it had to be pumped this distance. Fortunately, an arrangement was worked out utilizing the water that is provided for the two 100-t. absorption type, refrigerating machines installed in the wax plant nearby. This water, in its passage over the various cooling and condensing coils, picks up only sufficient heat to raise the temperature 5 deg. F. It is then delivered to the turbine condenser by the centrifugal circulating pump and used again for condensing steam.

Rather than discharge this water to the sewers, a line was laid to the lubricating oil stills, where the warm water from the condenser discharge is ideally suited for condensing and cooling the wax and lubricating oil streams. Warm water is more desirable for this purpose than cold water because cold water is likely to congeal the wax in the coils and cause plugging.

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TESTS ON BOILERS made by Lavington E. Fletcher and reported by Dr. Telford Petrie, chief engineer of the Manchester (Eng.) Steam Users' Association have shown that cast iron is undesirable as material for necks, domes and nozzles because of failure without warning, whereas wrought iron or steel castings fail gradually, with ample warning of approaching trouble.

It was also shown that turning feed onto an overheated furnace crown does not result in sudden dangerous generation of a large amount of steam, though it is not to be recommended because of the strains set up in the metal by sudden cooling.

As an interesting side light on hydraulic tests, one discarded boiler, in which metal originally 5/16 in. thick had been corroded at points to paper thickness, carried 370 lb. pressure before failure, the original designed working pressure being 130 lb. Another Lancashire boiler, 30 ft. by 6 ft. 6 in., built for 60 lb. and reduced to 50 lb. allowed and later to 15 lb. because of wastage of material about the rivets in the water space, failed under 225 lb. pressure in the steam space not near the wasted section.

Dr. Petrie suggests that boilers designed for pressures below 200 lb. should be tested to 1¾ times working pressure with maximum difference of 100 lb. per sq. in. For working pressures of 200 to 650 lb., he suggests a like test with a maximum pressure difference of 250 lb. per sq. in.

# Calculating Tonnage of Coal in Storage Piles

FROM AREAS OF CROSS SECTIONS OF PILE MEASURED WITH TRANSIT AND STADIA ROD OR WITH LEVEL, ITS VOLUME CAN BE EASILY FOUND. BY PAUL F. ROGERS

CALCULATING the amount of coal in an irregular storage pile is a problem confronting many engineers usually for purposes of inventory. In many plants it is the custom to measure stocks on hand each month to check against the automatic coal scale totals. Such measurements can be made in a few minutes by a surveyor and in plants where one is available the engineer will save time and trouble by getting him to do it. If a surveyor is not available, two methods can be followed, depending upon the equipment available.

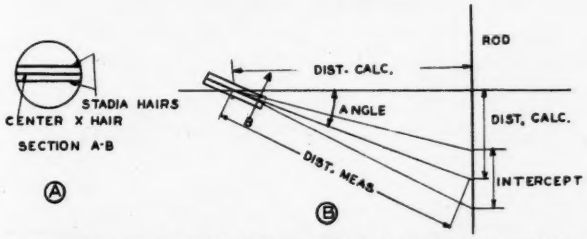


FIG. 1. CONSTRUCTION AND METHOD OF USE OF A STADIA TRANSIT

The easiest method is by means of a transit and stadia rod. The transit is set up at some convenient point or points and readings are taken for a survey of the pile just as though a topographical map were being made.

A stadia transit has three horizontal hairs as shown in Fig. 1A. One of these hairs, the center one, is used for reading all angles, etc., while the other two are spaced so that when sighted on the stadia rod they will intercept a given amount at a given distance. This is usually made one foot at a distance of 100 ft. From the intercept and angle made with the horizontal the distance from an elevation in relation to the instrument can be calculated, or, more conveniently taken from tables.

From a number of these readings a contour map can be drawn. Contours should be drawn every foot or two feet, depending upon how irregular the pile is. A typical storage pile for a locomotive crane with the top leveled would look something like that shown in Fig. 2A.

Areas enclosed by each contour can be estimated by counting squares of ordinary cross section paper or can be found by means of a planimeter, an instrument which is available and should be familiar to all engineers.

## AREAS ENCLOSED BY CONTOURS USED TO CALCULATE VOLUMES

All piles are prismoids, that is, solids with parallel end areas and composed of a combination of prisms, cylinders, wedges, pyramids and cones, or combinations of these. As the volume of a cylinder is hA, of a wedge hA ÷ 2 and a cone and pyramid hA ÷ 3 the volume of all of them or frustrums of them reduce to a common expression

$$v = \frac{h}{6}(A + 4A_m + A_2) \qquad (1)$$

Where v = volume in cubic feet.
h = distance between sections or contours in feet.
A = area of base in square feet.
$A_2$ = area of top in square feet.
$A_m$ = area of middle section in square feet.

A somewhat simpler formula for more or less permanent piles is

$$v = \frac{h}{3}(A_1 + 4A_2 + 2A_3 + 4A_4 + 2A_5 + \ldots\ldots A_n) \qquad (2)$$

Where v and h are the same as before and A, $A_2$, etc., are various sections taken from the bottom up.

For using this formula, the height of the pile must be determined and contour intervals selected so that the pile is divided into an even number of layers, so that n will be an odd number; that is, the height of the pile is divided into an even number of divisions and the area of sections found at the points of division. Then add together the first and last areas, twice the sum of all other odd sections and four times the sum of all other even sections and multiply the sum by one-third the common distance between sections, in this case the contour interval. The various sections are shown in Fig. 2B.

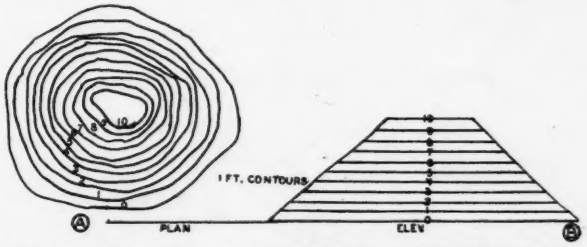


FIG. 2. PLAN AND ELEVATION OF A TYPICAL SMALL STORAGE PILE FROM A LOCOMOTIVE CRANE

## LEVEL CAN ALSO BE USED

Another method which is somewhat simpler for an engineer consists of running a line of levels over the piles in a number of places and finding cross-sectional areas as shown in Fig. 3. These sections are usually of the type shown in Fig. 3B. They can be plotted on cross-section paper and measured with a planimeter or they may be calculated mathematically. The areas of trapeziums, that is, quadrilaterals with no parallel sides, are best found by splitting up into triangles as in 3C. The area of any triangle is equal to one-half the product of the base by the altitude (measured at right angles to the base). If the top and bottom are parallel as in 3B, the area is

$$A = \frac{(AD + BC)\ h}{2} \qquad (3)$$

Figure 3D is found only in closed storage or with

concrete walls as in underwater storages. The area is also obviously

$$A = \frac{(AB + DC)\ BC}{2} \qquad (4)$$

Sections made up like Fig. 3E, sometimes with even more sides, can be split up or an equivalent triangle formed. For instance, if the area ABCD is desired, an equivalent triangle can be formed by drawing the line BD, then drawing CF parallel to it. It is a simple matter to prove the area ABCD is equivalent to area ABFD, which in turn is $\frac{AF \times BE}{2}$

If these sections have been taken at equal intervals, the volume between any three can be calculated as be-

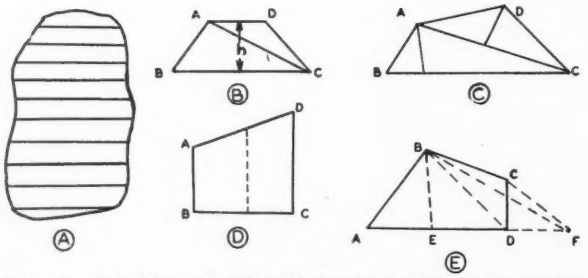


FIG. 3. DIFFERENT SECTIONS FOUND IN COAL PILES

fore by means of Eq. 1. If the intervals are selected properly, so that there is an even number of divisions, the entire volume can be calculated at once by means of Eq. 2.

The level method is easiest for an engineer not used to using a transit and if a regular surveyor's level is not available, an ordinary large spirit level, such as all carpenters and most mechanics have, can be utilized.

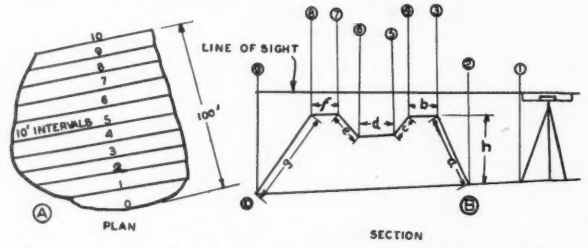


FIG. 4. METHOD OF USING LEVEL FOR CALCULATING COAL TONNAGES IN STORAGE PILES

This improvised level is set up at a point in line with, and slightly above, the highest point of the pile through which a section is desired as in Fig. 4B. The top of the level is used to sight with just as a gun would be sighted.

A light straight rod—20 ft. is a convenient length—should be marked in feet and tenths and used with the level. Suppose the coal pile is 100 ft. long, as in Fig. 4, dividing this into 10 equal intervals would give an interval of 10 ft. between sections.

First, the rod is set up just in front of the level as in 1 and the elevation of the level above ground determined, then it should be moved to 2, then to 3, etc., measurements being taken at every break in the slope as shown in Fig. 5B, which is a common section in a pile being stored and reclaimed continually by a drag scraper. Subtracting the reading at 3 from that of 2 will give the height h. The distance of all the slopes, such as, a, b, c, d, e, f, and g must be measured with a tape. Knowing the distance and height of each point, they can be plotted on cross section paper and the area found by counting squares or by a planimeter. If the ground is level or with a regular slope, the figure should close at point 10 to give a check.

The following notes are taken from an engineer's notebook:

LEVEL READINGS AND MEASURED DISTANCES AS USED FOR CALCULATING VOLUMES

Section 4

| Station | Rod | Elevation | Distance |
|---|---|---|---|
| 1 | 11.0 | .. | ... |
| 2 | 11.3 | 0.3 | 25.3 |
| 3 | 1.4 | 9.6 | a 18.2 |
| 4 | 1.6 | 9.4 | b 9.7 |
| 5 | 4.3 | 6.7 | c 6.6 |
| 6 | 4.4 | 6.6 | d 8.1 |
| 7 | 1.2 | 9.8 | e 9.2 |
| 8 | 1.8 | 9.2 | f 4.8 |
| 9 | 11.7 | 0.7 | g 20.2 |

A rough pencil sketch of each section similar to Fig. 4B should be made at the time the notes are taken to be used as reference later. Of course, accuracy is not great by this method but in an irregular coal pile accuracy is not great anyway even with precision instruments. Each time a reading is taken the rod should be held vertical and set on a spot leveled to about the general level of the pile; set on a lump or in a depression, it can easily make an error of half a foot.

After all the sections have been found and plotted the volume can be calculated by either Eq. 1 or 2. The weight per cubic foot will vary considerably with the kind and size of coal. This can be found either by taking a box of known size and filling it with a representative sample, or, if the cars are weighed on a scale in the plant before and after unloading, a good way to do is to get the net weight and measure the car to get the volume; not the entire volume of the car but the space occupied by the coal. This is a simple matter and can be done with an occasional car as the weight will vary some from time to time, especially in rainy weather.

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IN A RECENT paper on transmission and distribution economies for smaller communities presented before the Iowa section of the N. E. L. A., W. J. Neal of the Iowa Public Service Co. said that "furnishing of service to small towns over large areas requires lower costs for transmission and distribution but quality of construction and maintenance must not be lowered to the extent that service will be affected. These small towns have a limited kilowatt-hour consumption and if rates are to be kept within reason, it is necessary to develop construction and maintenance methods which will result in lower costs."

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RAGS RATHER THAN waste should be used in a Diesel engine plant.

# Comfort for Fish in Steinhart Aquarium

HEATING, REFRIGERATING AND PUMPING PLANT MAINTAINS NATURAL CONDITIONS FOR FISH. BY C. W. GEIGER

FEW PERSONS realize that aquariums require a heating plant, refrigerating plant, filters, etc. An idea of the extensive equipment required to operate a large aquarium may be gained by a description of the equipment installed in the $250,000 Steinhart Aquarium in Golden Gate Park, San Francisco.

Approximately 57 large glass-fronted wall exhibition tanks, each holding from 1200 to 1400 gal. of water, and

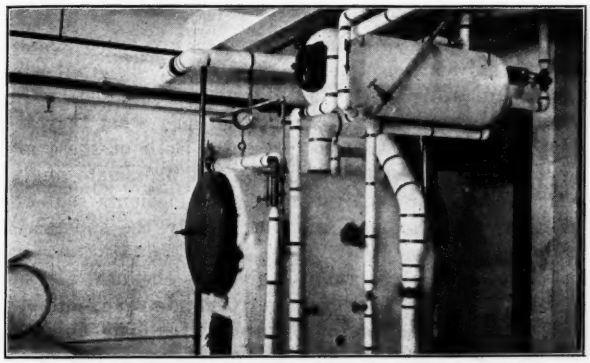

FIG. 1. BOILERS IN STEINHART AQUARIUM

approximately 61 balanced aquarium tanks, each holding from 5 to 200 gal. are installed. In addition, there are 10 vivariums.

Closed circulation is the system used throughout, a valuable and unique feature being unit control for each tank. Four kinds of water are circulated: warmed salt water, salt water of normal temperature, cooled fresh water and fresh water of normal temperature.

All machinery is electrically operated and automatic. All saltwater pipes are of heavy lead with monel metal valves. About 900,000 gal. of water are circulated daily, exclusive of the flow to the outdoor pools and fish hatchery.

## SUPPLY OF WARM AND COOLED WATER

For the purpose of providing water at the proper temperature for fish from the tropical waters, a complete heating plant is operated in connection with the aquarium and for the purpose of providing cooled water for fish from the Arctic a complete refrigerating plant is operated in connection with the aquarium. The refrigerating plant, like all the other apparatus, is automatically controlled throughout. It was supplied by the American Ice Machine Co. of San Francisco and embraces some unique features in this character of apparatus.

Normal control of the plant is effected by means of a submerged type of thermostat, the control element of which projects into the water of the refrigerated tank in the tank house on the roof. This thermostat is readily adjustable for absolute temperature and for range of temperature, the means for which are located in the part of the thermostat projecting from the tank. A variation of a degree or two in the temperature of the refrigerated water causes the thermostat to make the appropriate contact either to start or to stop the refrigerating plant by means of the motor control panel in the engine room.

Abnormal control of the plant is effected by means of an automatic cutoff and safety relief valve connected between the discharge and suction headers. This automatic cutoff operates on a thermal principle instead of a pressure principle, thus providing protection not only against excessive pressure, but also against overheating of compressor cylinders in case of clogged water jackets, which pressure control does not do. It not only stops the plant in case of abnormal conditions but also starts it up again when conditions have returned to normal.

Two expansion circuits are installed, one feeding the ice water tank on the roof and the other feeding a small refrigerator for the storage of food supplies, each circuit controlled by an automatic adjustable expansion

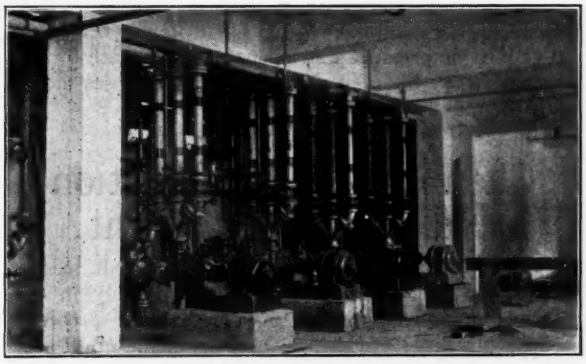

FIG. 2. PUMPING EQUIPMENT SUPPLYING FILTERED WATER TO TANKS

valve. The coils of the ice water tank, which is 6 ft. 9 in. by 6 ft. 9 in. by 6 ft. of $\frac{3}{16}$-in. steel plate welded and insulated with 4 in. of sheet cork laid up in hot asphalt, consists of 600 ft. of 1¼-in. welded pipe galvanized after welding. The coils of the refrigerator box are of 1¼-in. black continuously welded pipe, placed in a galvanized tank and surrounded by a solution of calcium chloride brine of proper density to freeze at 15 deg. F., for the purpose of maintaining the temperature of the refrigerator by means of congealed brine during the periods of automatic shutdown.

Operation of the system is carried out on the following cycle: Water in the roof tank is chilled to the desired point, approximately 52 deg. F., by the expansion coils. It flows thence by gravity to a distributing main above the 13 cold water fish exhibition tanks, to which it is distributed by adjustable nozzles feeding the water through glass tubes, at the same time drawing air in, on the injector principle, to aerate the water. From the fish exhibition tanks, the cold water overflows to a collecting main, thence to a sand filter in the engine room and collects in a sump tank under the filter. From

here it is pumped by a centrifugal pump back to the roof cooling tank. This pump, similarly to the other pumps, is controlled automatically by a float switch in the roof tank, the float being set to operate on a difference of water level of about one foot. All of the distributing pipes for this cold water are insulated with cork covering, and the fish tanks, filter and sump tanks are insulated with 2-in. sheet cork laid in hot asphalt.

An American automatic adjustable water control valve supplies water to the condenser and to the water

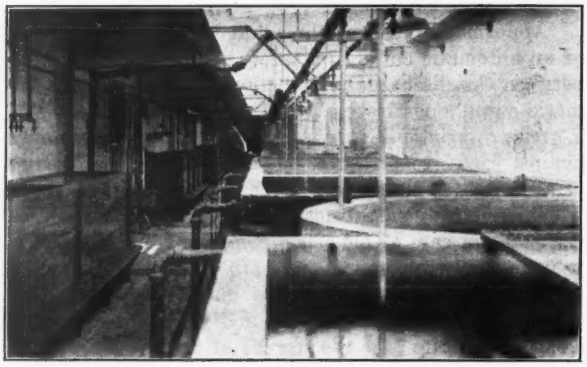

FIG. 3. FILTERED WATER PIPING TO EXHIBITION TANKS

jackets of the compressor. This valve is operated by the condenser pressure and opens proportionate to such pressure, when the plant is operating, and closes shortly after the plant shuts down.

## Chemistry of Combustion and Water Treatment

CHEMISTRY is a subject with which all modern power plant engineers must deal, largely in connection with combustion and water-treating problems. All substances with which we deal are made up of some form or compound of a number of basic materials or elements, such as, iron, carbon, oxygen, and hydrogen. In usual plant practice, about 20 such elements have to be dealt with.

These elements always combine in certain definite proportions. When elements or their compounds are mixed, a chemical change called a chemical reaction takes place. In some cases, this reaction is reversible, while in others it is not.

Among the most common compounds are acids and bases. Chemically, acid is a compound of hydrogen, a nonmetallic element, and usually, but not always, oxygen. Thus hydrochloric acid is a compound of hydrogen and chlorine and contains no oxygen, while sulphuric acid is a compound of hydrogen, sulphur and oxygen. Acids usually have a sour taste and turn blue litmus paper red. The nonmetallic element is easily replaced by a metallic element releasing hydrogen gas and forming a salt. Most corrosion is due to this action.

Bases, on the other hand, are the direct opposite of acids. Although they contain hydrogen and oxygen in a form known as the hydroxide, these elements are in combination with a metallic element instead of nonmetallic as in acids. Bases are also commonly called hydroxides, alkalis and caustics, common examples being caustic potash or potassium hydroxide, and caustic soda or sodium hydroxide. They have a soapy feeling and turn red litmus blue.

Bases and acids react to form salts, usually a combination of the metallic and nonmetallic elements. By the addition of sufficient acid, bases can be neutralized. This branch of chemistry dealing with minerals and metals is known as inorganic chemistry. There is another branch known as organic chemistry, which, however, is not quite as important in our field.

This second branch is sometimes termed the chemistry of carbon. Formerly it was supposed that organic compounds could not be made in the laboratory, but this has been found to be untrue. The most important organic compounds to power plant engineers are the carbon and hydrogen compounds found in lubricating and fuel oils.

Two methods of chemical analysis are used. Qualitative analysis is a determination of the different substances of which a certain thing is composed, while quantitative analysis determines not only what they are but how much of each is present. Both of these are further subdivided into ultimate and proximate analysis. An ultimate analysis states the elements that are present, the proximate analysis simply the substances of which it is composed.

An ultimate coal analysis gives its chemical constituents as carbon, hydrogen, nitrogen, oxygen, sulphur and sometimes ash and moisture. Proximate analysis, on the other hand, is a mechanical process to determine usually the moisture, ash, volatile and fixed carbon.

Qualitative analysis is carried out by adding various substances and forming precipitates which can be identified by color or appearance. In qualitative analysis, amounts are determined in one of two ways: gravimetric analysis by weight or volumetric analysis by using measured volumes. Volumetric analysis is rapid and accurate and is usually used for power plant determinations, using chemicals of known standard strengths in long graduated tubes known as burettes from which the flow can be controlled a drop at a time.

## Leather Gloves as Protection on 480 Volts

SOME LINEMEN declare that a good pair of leather gloves will give adequate protection on 480 v. Recently some laboratory tests were made indicating that while a good *dry* leather glove might be considered fairly safe for use on this voltage, a very small amount of moisture in the leather will reduce its insulating value practically to zero. It is rarely, indeed, especially in the summer months, that a man will not perspire enough to moisten the leather to a dangerous point. A slight wetting from rain will do the same thing. After leather gloves have been worn a while, they can hardly help being cut, scratched and scuffed, so even when perfectly dry they might be unsafe. The conclusion from these tests was that leather gloves are not adequate insulating protection for a man working on a 480-v. line.

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AIR AND MOISTURE make a combination that causes much destruction in power plants. If air could be kept out of water and steam, and water out of air, most of the loss due to corrosion would be avoided.

# Beauty and Utility Combined in Diesel Plant

EMAUS, PA. WATER WORKS POWER PLANT, BEAUTIFUL IN CONSTRUCTION AND COMPLETE IN MODERN EQUIPMENT, AVOIDS ALL OBJECTIONS TO LOCATION IN RESIDENTIAL DISTRICT

MODERN TRENDS of Diesel power plants toward beauty of surroundings and completeness of equipment with Diesel power accessories are incorporated in an outstanding way at the power station of the Emaus Water Works which was started in operation on December 22, 1928.

### BEAUTY OF CONSTRUCTION AND LANDSCAPING

Housed in a building 66 ft. wide by 42 ft. deep, whose walls both inside and out are of light monumental stucco plaster; whose trim is of deep red, rough-texture, face brick and whose roof is of tile, with appropriate landscaping, the water works plant forms such an improvement to the property that residents will be attracted rather than deterred from building dwellings in the vicinity.

Pumping of the city water supply is accomplished electrically, electricity being generated by a 150-kv-a. Crocker-Wheeler alternator which operates its 7-kw. exciter by chain belt drive and is direct connected to a 240-hp. Superior-Otto Diesel engine. In this particular engine, features of the former Otto and Superior engines have been combined. These features, however, have been developed during the years of engine building experience of the two former organizations. The engine is built under Deutz patents, the principal features being shown in Fig. 1.

In the plant operation, water is raised by the air lift method from two wells, one 311 ft. and the other 375 ft. deep, in which water levels of 60 and 75 ft. respectively are maintained. The water is discharged into the lower reservoir which is constructed of reënforced concrete below the ground level and is 35 by 35 ft. in area with a depth of 6 ft. Compressed air is supplied by a two-stage Ingersoll-Rand air compressor which is belt driven through a pulley idler system by a Crocker-Wheeler 100-hp. alternating-current motor.

Water is drawn from the lower reservoir, which is located alongside of the plant, by a Dayton-Dowd centrifugal pump and discharged into the line which feeds the reservoirs on the hill back of the plant. One of these reservoirs has a capacity of 220,000 gal. and, when filled, supplies a pressure of 93 lb. The other which is a 175,000-gal. reservoir, exerts a pressure of 55 lb. on the mains, when filled.

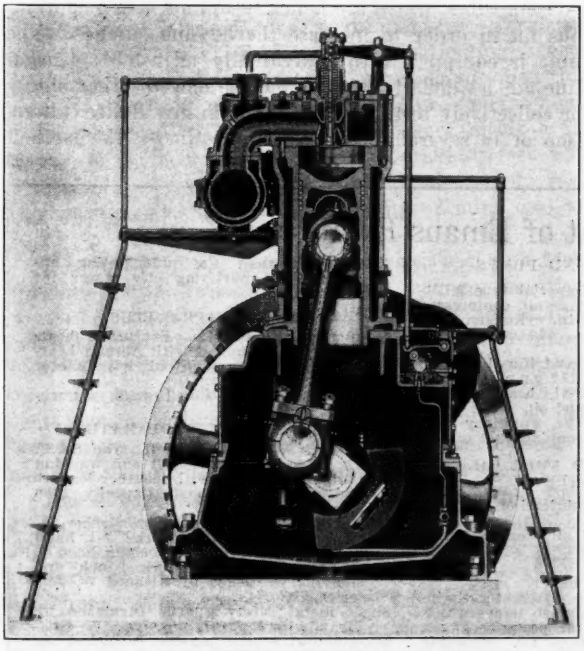


FIG. 1. CROSS SECTION OF SUPERIOR-OTTO DIESEL ENGINE USED AS MOTIVE POWER FOR PLANT

### AMPLE SUPPLY SIMPLIFIES COOLING WATER PROBLEM

Cooling water is taken direct from the mains, which are supplied with water from the upper reservoirs and, after passing through the water jackets of the engine, is discharged into the lower reservoir, so that it is

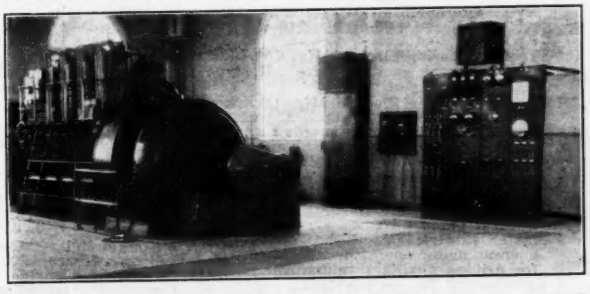


FIG. 2. 240-HP. SUPERIOR-OTTO DIESEL OIL ENGINE DIRECT CONNECTED TO 150 KV-A. CROCKER-WHEELER ALTERNATOR AS INSTALLED AT EMAUS

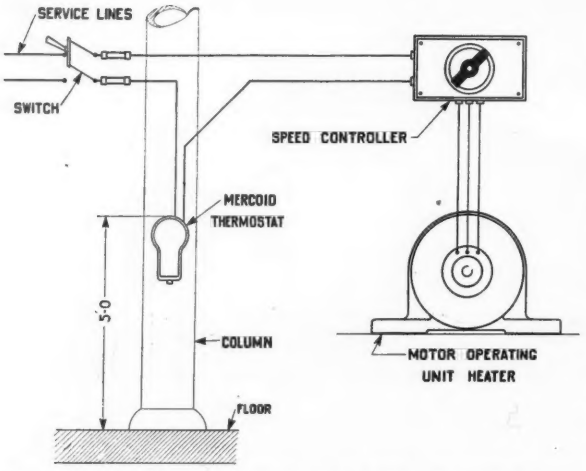



FIG. 3. SENSITIVE, QUICK-ACTING THERMOSTAT REGULATES TEMPERATURE BY STARTING AND STOPPING MOTOR WHICH IS ATTACHED TO FAN

actually returned to the regular city water supply line. In this way, no cooling device is required and, since the water is exceptionally soft, no water treatment is necessary.

Gulf Refining Co. Solar oil of 28 to 34-Baumé test is used for fuel. It is purchased at 6.15 cents a gal., delivered by gravity from the car to the two 10,000-gal. steel storage tanks which are located on piers alongside of the railroad. A small rotary pump attached to the engine pumps the oil from the storage tanks through a Buffalo oil meter to the day tank in the engine room, a motor-driven centrifugal pump being supplied for emergency purposes.

### Air Cleaning Protects Engine Parts

Air intake for the engine is located on the outside of the building. The air is passed through a two-unit-type S.C.F. Reed air filter which is protected from the weather by louvers. Adhesine is used in the washing tank, in which the units are replaced at periodic intervals for cleaning and recharging with the oil which entraps the dust particles as they pass into the unit, preventing abrasion of the wearing surfaces of the engine. Employment of air filters has also made possible longer use of lubricating oil without change than would otherwise be advisable.

### Exhaust Discharge Noiseless

Exhaust gases from the engine are water-cooled in the manifold as shown in Fig. 1 and are discharged through a Maxim silencer to the atmosphere. Gulf Refining Co. lubricating oil is used and is passed continuously through a filter attached to the engine. All bearings are flooded with oil by means of self-contained rotary pumps arranged in a group of three, one of which lifts the oil from a sump pit in the base to the filter, the second pump receives the clean oil from the filter and forces it under pressure to the cylinders and principal bearings and the third pump, which is hand operated, is used only when starting the engine. When rotated in one direction, this third pump lifts oil from the sump to the filter and, when turned in the opposite direction, forces the oil from the filter to the bearings. Oil pressure is shown on a gage. The lift pump discharges into the filter more oil than is circulated in the pressure system, the surplus overflowing to the governor, fuel pump and valve gear. Lubricant consumption is under one gallon per 2500 hp-hr.

Two air bottles for starting are located outside of the building. The engine foundation is of concrete, built separate from the floor to the station.

### Automatic Station Heating

Unusually good provision for heating the engine room was made by the installation of an American Blower Co. oil-fired Venturafin unit heater with recirculating box which takes the air from the floor level and feeds it to the fan which forces it over the Aerofin heating coils and into the areas required to be heated. Air is drawn into this unit by a motor-driven Ventura fan which has propeller blades. It passes around Aerofin tubes, which are helically wound with a continuous fin in order to increase the heating surface. The unit is equipped with individually adjustable streamline air jet deflectors which can be moved either singly or collectively to throw heated air in any desired direction or in several directions at one time. The method

## Principal Equipment of Emaus Plant

**PRIME MOVERS**

1 240-hp. Superior-Otto Diesel oil engine, 4-cylinder, 4-cycle, solid-injection type running at 257 r.p.m.
1 Crocker-Wheeler Electric Mfg. Co. 150-kv-a. alternator. Size 101-S-28, type ALT, 3-phase, 60-cycle, 240-v., 257 r.p.m.
1 Crocker-Wheeler Electric Mfg. Co. 7-kw. direct-current exciter. Size AH, type C.C.D. 1450 r.p.m.
1 Crocker-Wheeler Electric Mfg. Co. Size 23Q, Type S.C., 100-hp., 220-v., 3-phase, 60-cycle motor running at 860 r.p.m. for driving air compressor through idler pulley belt drive.
1 Crocker-Wheeler Electric Mfg. Co. 3-phase, 60-cycle, 60-hp., motor, size 15 R, Type S.C., 220-v. for driving centrifugal pump.
1 Master Electric Co., ⅛-hp. alternating current motor operating at 1725 r.p.m. for driving auxiliary centrifugal pump.
1 Switchboard Co., switchboard.
1 General Electric Co., Tirrill voltage regulator.

**COMPRESSOR AND PUMPS**

1 Ingersoll-Rand Co., Imperial type XRB-2, horizontal, two-stage air compressor with 15 by 9 by 12-in. cylinders. Capacity at 175 r.p.m., 460 cu. ft. free air per min.
1 Dayton-Dowd Co., centrifugal pump, size 4 C.S.D., 600 to 750 g.p.m. capacity against 180 to 250 ft. head at 1730 r.p.m. for pumping fuel oil.
1 Mechanical Devices Co., auxiliary centrifugal pump for pumping fuel oil.

**LUBRICANT AND FUEL OIL APPARATUS**

2 S. F. Bowser & Co. lubricating oil tanks and filters.
2 10,000-gal. steel fuel oil storage tanks.

**INSTRUMENTS**

1 Buffalo Meter Co. oil meter.
1 Brown Instrument Co. pyrometer equipment for engine exhaust temperature.
Foxboro Co. recording air pressure gages.
1 Builders Iron Foundry Co. recording Venturi flow meter.
1 Wallace-Tiernan Co. chlorinating apparatus for purifying city water for drinking purposes.

**HEATING APPARATUS**

1 American Blower Co., Venturafin heating system supplied with Aerofin heating elements and fitted with motor driven Ventura fan.
American Radiator Co. heating connections.

**MISCELLANEOUS APPARATUS**

1 Reed Air Filter Co. 2-unit, type S.C.F. air filter with spare cell and washing tank and supplied with weather louvers and recirculating box. Capacity 1200 c.f.m.
1 Maxim Silencer Co. exhaust silencer.
1 Roeper Crane & Hoist Works, 3-t. hand operated crane with 3-t. chain hoist.
Steel fixtures—lockers, work bench and shelving furnished by Richard W. Jefferies & Co.
Sheet metal safety guards furnished by Strandwitz & Scott.
Monumental stucco plaster furnished by Kelly Plaster Co.

of automatically regulating the temperature of the space to be heated is illustrated in Fig. 3. A Mercoid thermostat, which is a quick-acting sensitive instrument, starts and stops the fan motor as the temperature varies.

### Good Lighting Aids Station Management

Fine natural lighting secured through many windows on four sides of the building is supported for night service by nine 100-w. electric lamps. These lights, which are arranged in clusters at two levels, provide ample artificial light. Other facilities for superior operation of the Emaus plant are a Brown pyrometer, Bowser lubricating tanks, a Tirrill voltage regulator and a 3-t. Roeper crane.

Joseph L. Sweigard of Philadelphia was the consulting engineer and Wesley S. Frey is the water works engineer.

# Powdered Coal for Avondale Mills

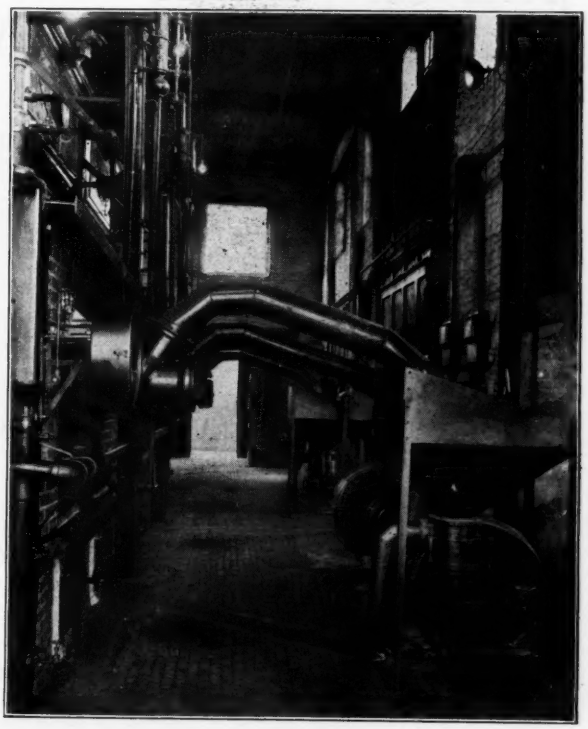
### Unit Pulverizers in Industrial Plant Increase Capacity of Boilers and Economy of Plant

AT PELL CITY, Alabama, the Avondale Mills have recently effected the modernization of a 25-yr. old boiler plant with interesting results, economically. The results are particularly valuable for two reasons: they show that it is a comparatively simple matter to take advantage of improvements in boiler plant practice and they furnish a striking example of the comparative economy of modern methods. The mill itself is a 22,500-spindle cotton mill making denims and operating its own dye house and finishing department. As a result, there is a large demand for steam, both process and otherwise, the former including steam for such work as slashing, dyeing, drying and humidifying. In the latter case, the load comprises a small absorption ice plant, a laundry and, in the winter, additional steam for heating the mill, the office and some adjoining school buildings. The original installation which supplied this demand consisted of five 220-hp. Heine boilers, horizontally baffled. The front headers were about 5 ft. above the boiler room floor and the grate surface was 47.5 sq. ft. They were all hand-fired, the yearly coal consumption averaging 7700 t. of run of mine coal at $3.25 per ton delivered.

Consideration was given to pulverized coal as a fuel, for two special reasons. First, the fuel consumption would be reduced and second, a less costly grade of fuel could be utilized. Alabama washed coals of equivalent heat value but in sizes not suitable for hand or stoker operation were available at savings of from 30 to 60 cents per ton delivered. Also, the construction of the boiler room proper was such that the necessary changes could be made without a great deal of trouble.

The changeover, which was made by the Fuel Efficiency Engineering Corp. of Birmingham, consisted in raising three of the boilers about 4 ft. and moving them forward about 7 ft. ahead of the existing smoke breeching. When moved, they were suspended from an overhead gallows at the front and were supported at the rear by a steel framework under the headers. The forward movement gave sufficient furnace volume to permit peak ratings of as high as 200 per cent per boiler. Each boiler was equipped with a Size C Warrior coal pulverizer equipped with Timken bearings and driven by a 25-hp. squirrel-cage induction motor, with manual compensator starting. Preheated air is delivered at the feed end of each pulverizer, which aids its operation by removing the moisture content usually found in small sizes of washed coal. Combustion control is by hand regulation of the pulverizer feeder and the furnace draft. The $CO_2$ averages about 12 per cent.

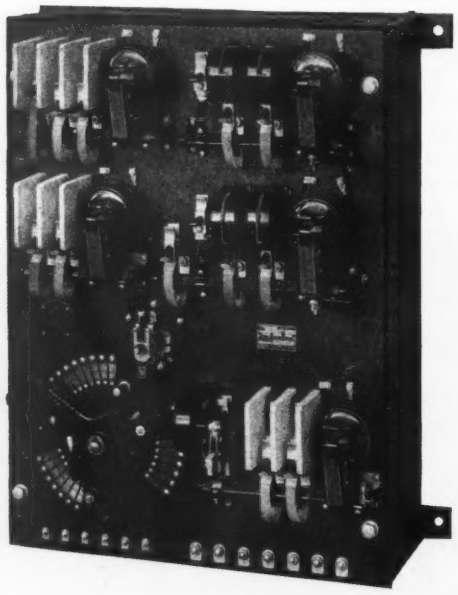
Although the installation in its new form has been operating only about 6 mo., some interesting facts have already developed concerning its comparative economy.



UNIT PULVERIZERS IN AVONDALE MILLS

It might be explained, before going into details with regard to the savings effected, that the mill is on a 10-hr., five and one-half days per week schedule. The night load is comparatively low, being from 50 to 100 hp. normally. Formerly, it took three boilers to carry the load under normal conditions, and in the winter it was difficult to maintain steam pressure unless a fourth was cut in. At present, two boilers can carry the load at all times. Thus it is possible to work them in rotation and give them proper care. Each one is kept in operation about three weeks and then shut down to permit removal of the furnace ash and washing of the boiler. Therefore, there is no reason for deferred maintenance becoming a factor in operation costs. Because of a lack of reliable monthly fuel cost records covering the period prior to the changeover, it is impractical to give an accurate statement of the fuel savings effected; however, comparison of six months' figures for corresponding periods shows a reduction of 25 per cent in the quantity of fuel used, to which should be added a saving of 35 per cent a ton on the coal purchased.

# Industrial Controllers



## *Make Possible*

# GOOD MOTORIZATION

PART I

*By* W. C. Yates
*Industrial Department*
General Electric Co.

ADVANTAGES of electric motor drive of industrial machinery are, in general, well understood and the rapid way in which they are supplanting other kinds of power units is a matter of record. As soon as reasonably well-designed motors were available, their advantages over other kinds of drive were easily demonstrated. One particularly important factor was the ease with which the motor could be controlled. This, with other advantages, influenced the early introduction of motors to drive line shafting and has become the prime consideration in the application of the electric motor to the individual drive of industrial machines.

Much of this evolution can be attributed to the improvements made in the characteristics of "general purpose" motors, as well as to the development of new types especially suited to some particular application but it may not be fully appreciated how much is due to the still greater advance in the developments made in the *controlling devices and equipment used with these motors.*

Industrial controllers exist in such an astonishing variety of types and forms as to confuse anyone not an expert in this field. The selection of a proper motor for a given service, apart from that of a very special nature, is a relatively simple matter and concerns chiefly the power available, the work to be done and the general conditions surrounding the installation. While these are usually given intelligent study, it is often true that the controller is chosen with less care and understanding.

It is not sufficient that the controller shall permit the motor to go through its desired performance. Consideration is due the wearing qualities of the device; the safeguards afforded the motors, the machine and the material handled; the elimination of hazard to life and limb; the convenience as to installation, inspection and repair; the economies of operation and other factors that merit attention. The consideration that merits least attention is that of first cost. The controller for a motor driving a given machine plays, ordinarily, a minor part in the cost of the complete installation but its failure in any way to maintain service or to get the best work out of the equipment will quickly counterbalance any false economy in its selection.

It appears, therefore, that it is worth while to understand better the industrial controller in its seemingly endless variety and, in many cases, its complexity. A study of what it has to do and the various methods of accomplishing the results will make relatively simple the selection of the right device for almost any service except that of a highly special nature.

### Selection of the Controller

Having chosen our motor in view of the power supply and the characteristics it must possess to meet the service requirements, let us select our controller. This cannot be done by going through a list of the various types available in their many combinations, but we can bring up one after the other the fundamental considerations and arrive at what we are searching for by a process of elimination. Let us first consider the duty and service.

By the duty, we mean the specific functions for which the controller is designed. Is it merely to start the motor and is the load to be accelerated light or heavy? Or is speed control desired and, if so, by what method? The motor must largely tell us whether the method is to be by armature or field rheostat, winding or voltage change, brush shifting and so on.

Must the motor be reversed and throughout the entire speed range? Must it be brought to rest quickly and is a solenoid brake, dynamic braking or "plugging" best?

By service is meant the specific application in which the controller is to be used; for example, (a) general purpose, which covers occasional starting of motors, (b) special purpose, which covers a long list of applications, such as cranes and hoists, elevators, printing presses, rubber mills, each of which demands some distinctive feature in the control in the way of capacity, specific functions and other points considered later in this discussion.

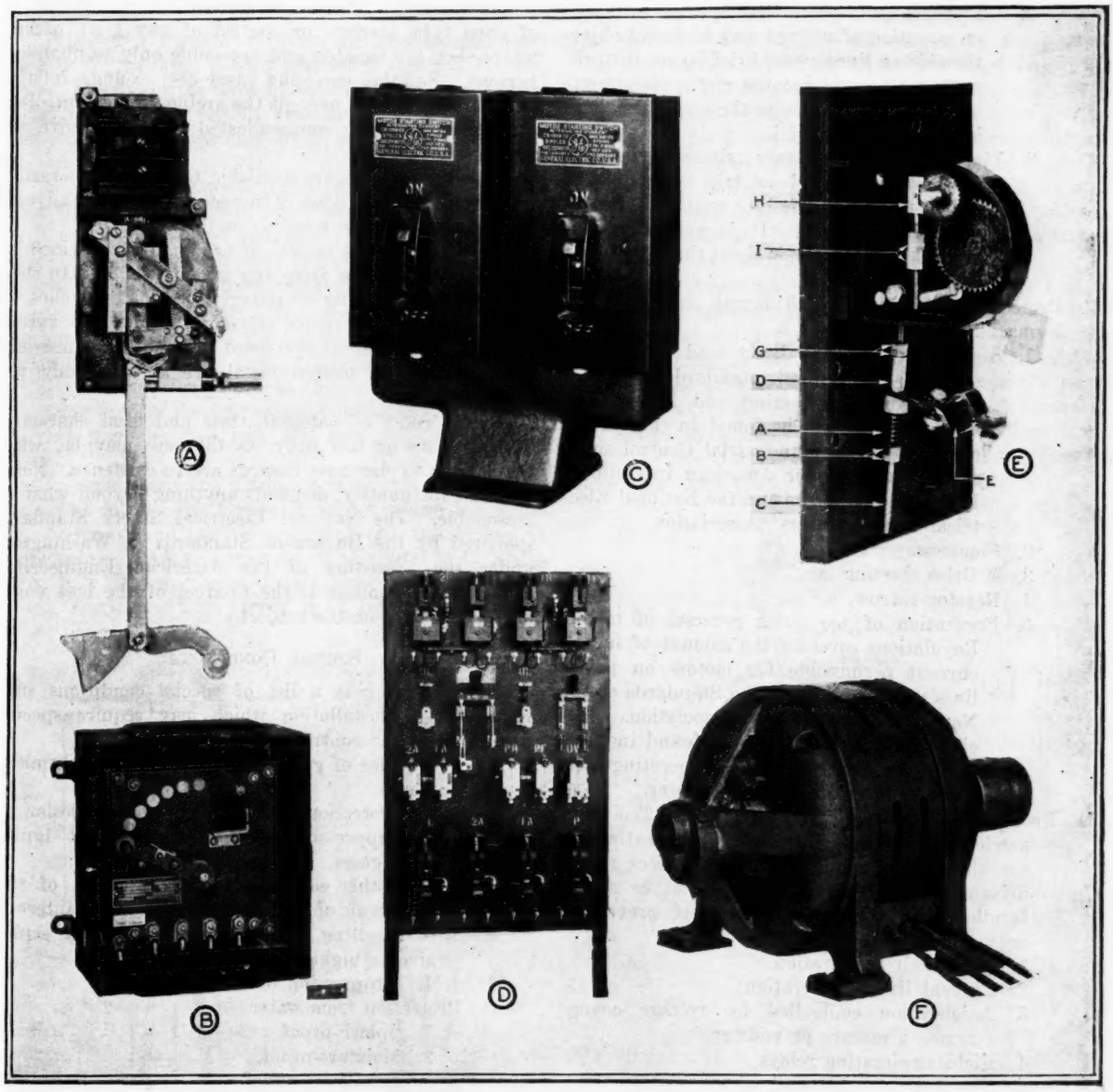
Following is a tabulated summary of the protective features that may be essential. Several of the items could be discussed at length to advantage, particularly those concerning ways and means to secure adequate overload protection, the relative merits of various motor starting methods and the advantages of the several automatic accelerating schemes.

A Overload Protection

The motor should be safeguarded against injurious overload.

This may be accomplished by:

1. Fuses (these have definite limitations as to protection afforded).
2. Circuit-breakers: Instantaneous and time-element.
3. Relays affecting contactors: Instantaneous and time-element; hand, gravity and remote reset.
4. Thermal devices




TYPICAL EXAMPLES OF CONTROL DEVICES FOR INDUSTRIAL MOTORS THAT IMPROVE PERFORMANCE AND OFTEN MAKE POSSIBLE OPERATIONS THAT WOULD BE IMPOSSIBLE IF DONE BY HAND

A—Time release attachment for undervoltage trip. B—Safety type manual starter with undervoltage protection, for d.c. motors. C—Motor-starting tumbler switches. D—Steel mill auxiliary reversing magnetic controller. E—Details of definite time attachment showing gears and adjustable pendulum ratchet. F—Typical 110/220-v. motor.

Theoretically ideal overload protection is accomplished by a device that will follow the temperature of the motor as caused by the load upon it and which will function to disconnect the motor when unsafe temperatures are approached. Thermal devices are available which will accomplish this with more or less exactness; motor starters and controllers are now usually found to be equipped with such devices.

B Under-voltage release
1. Motors that cannot be thrown directly on the line in safety to themselves should have starters equipped with under-voltage release.
2. Under-voltage devices that operate instantly on cessation of voltage may be found objectionable on lines where brief power disturbances may occur, because of the disconnecting of all the motors on the line when there is really no need of it.
3. Time delay under-voltage release devices are available which will not trip the controller unless the voltage failure continues for an appreciable period. It is generally considered that 1½ sec. is about the right delay to provide.

C Protection against too high inrush and shock to machinery.
1. Starting resistance, direct and alternating current. Recognized standard capacities and ratings of starting and intermittent duty resistors will be found in the American Standards on Industrial Control sponsored jointly by the American Institute of Electrical Engineers and the National Electrical Manufacturers' Association.
2. Compensator starter, a.c.
3. Y-Delta starting, a.c.
4. Reactor starter, a.c.
5. Prevention of too quick reversal of motor. Regulations covering the amount of inrush current permissible for motors on power lines will be found in the Standards of the National Electric Light Association. Special regulations will also be found in force issued by central stations operating network systems for light and power.

D Protection against too rapid acceleration. Too rapid acceleration may be the cause of heating or sparking of the motor or of undue shock to the driven machinery and the material or fabric handled by it. Ways and means of prevention are:
1. Time limit acceleration.
2. Current limit acceleration.
3. Acceleration controlled by voltage change across armature or resistor.
4. Field accelerating relays.

E Protection against overtravel of machinery
1. Limit switches.
2. Overwind device.

F Overspeed protection. (Required only in special cases.)

G Phase reversal and phase failure protection.

H Sudden strengthening of field at high speed will result in a voltage jump that must be taken into consideration in some instances.

For many reasons (humanitarian, economic and legal) much attention is given to the safety precautions surrounding industrial machinery.

Under-voltage protection automatically prevents the motor from restarting, without personal intervention, after failure of power. The casualties that might result from the unexpected starting of machinery are obvious. Phase-reversal protection is essential for elevators and other machines on which unexpected motor reversal would be hazardous.

Enclosure of the live and working parts of the control equipment, as a safeguard against shock or burn, is now the rule. There is no excuse for the installation of open type starters or control of any kind, except where they are isolated and accessible only to qualified persons. Suitable enclosing cases also exclude inflammable dust and will prevent the arcing of the controller contacts from being communicated to an explosive atmosphere.

Locking features are available to prevent operation while work is being done in inspecting, cleaning, adjusting, or repairing the machine or its equipment.

Emergency stops in case of need can be provided to shut down the motor from any given point and to stop it quickly by braking or plugging. Limit switches to prevent overtravel, as for elevators, cranes and valves and devices to prevent overspeed in handling dangerous material such as molten metal are an every-day requirement.

Safety codes of national, state and local character dealing more or less fully, as the case may be, with regulations to eliminate hazards are in existence. None of them, fortunately, demands anything beyond what is reasonable. The National Electrical Safety Standard sponored by the Bureau of Standards at Washington under the procedure of the American Engineering Standards Committee is the product of the best engineering thought on the subject.

### Special Conditions

The following is a list of special conditions surrounding the installation which may require special protection of the controller:

A Prevalence of gas or acid, as in mines, chemical works
1. Protection of controller from corrosion.
2. Suppression of arcs that might ignite gases.

In this connection, the Standards of the Bureau of Mines, will be found of interest.

B Mills handling powder, sawdust or other explosive or highly inflammable material
1. Suppression of arcing.

C Protection from water
1. Splash-proof.
2. Moisture-proof.
3. Immersion-proof.
4. Special protection from action of salt water.

D Fire prevention measures in general (See underwriters' code).

(To be concluded)

# Ejectors Monopolize High Vacuum Field

SIMPLICITY, LOW FIRST COST, LOW MAINTENANCE AND EASE OF INSTALLATION LARGELY RESPONSIBLE FOR POPULARITY OF STEAM JET VACUUM PUMPS

DURING RECENT YEARS, ejectors or steam jet air pumps have practically monopolized the high vacuum field particularly for condenser service. Aside from the economy and performance of the pumps themselves, there are considerations of space and weight which give this equipment considerable advantage. Being light in weight and free from rotating parts, no foundation other than a structural steel support is necessary and they may be located where and how conditions dictate.

When first introduced, these air pumps were used mostly for priming pumps and other intermittent services. Early forms were of the single-jet, single-stage type and had two serious disadvantages: they were of little use on vacuums over 20 in. and used a great deal of steam.

Higher vacuums were finally obtained by compounding, that is, using two or more jets in series as in Fig. 1 B and by improved designs. This compounding reduced the compression ratio of each stage and made it possible to design the tubes more efficiently.

In pumps of this type, the second stage is required to handle not only all the air pumped but the steam from the first stage as well. By installing a condenser, either jet or surface, between the two stages as in Fig. 2, steam used in the first stage is condensed out and the second stage handles only the noncondensed air and gases.

In some cases, the discharge from this second stage is piped to an open feedwater heater where the steam is condensed and the air separated out and vented to atmosphere. An arrangement of this kind is shown in Fig. 3, which represents the condenser layout at Bradford, England. This layout is of interest for several reasons and shows effectively the difference between foreign and domestic practice. Two condensers are installed, contrary to American practice which dictates individual condensate and vacuum pumps; these two condensers are piped up to the same pumps, the condensate duplicate pumps being installed in a pit and the ejectors in triplicate installed on a gallery at about the same elevation as the turbines.

Cooling water for the jet intercondensers is taken from the condensate pump discharge, passed through the condenser and back to the suction of the pumps. The ejectors themselves are of the two-stage type with water-cooled diffusers and as they differ considerably from American types, they are shown in cross section in Fig. 4. Cooling water enters near the outlet of the second stage, flows upward around the second stage jet diffuser and downward around the first stage diffuser which is arranged at the lower end to act as a jet condenser. Discharge from the second stage goes to the open heater, as mentioned previously.

Typical American practice is illustrated by Fig. 5, a two-stage ejector with a combined inter- and after-condenser of the surface type. Condensate from the main condenser is used for cooling the ejector condensers and the condensed steam from the primary jet is drained back to the condenser. Sometimes these drains are sealed by goosenecks as shown for the first stage and sometimes they are drained through float valves as shown for the second stage.

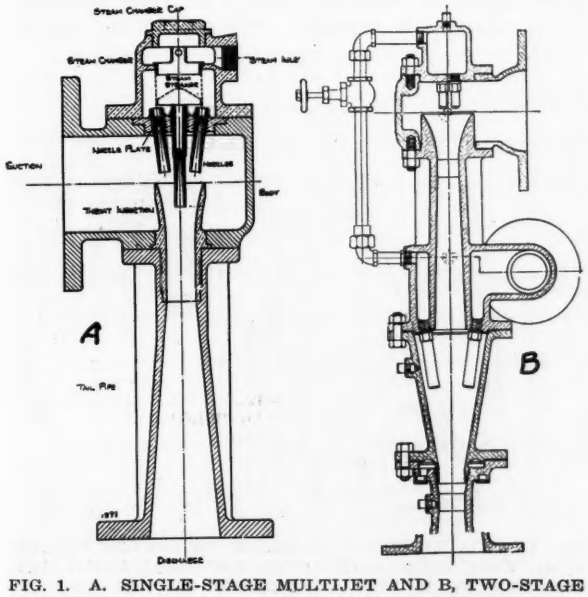



FIG. 1. A. SINGLE-STAGE MULTIJET AND B, TWO-STAGE MULTIJET EJECTOR WITHOUT INTERCONDENSER

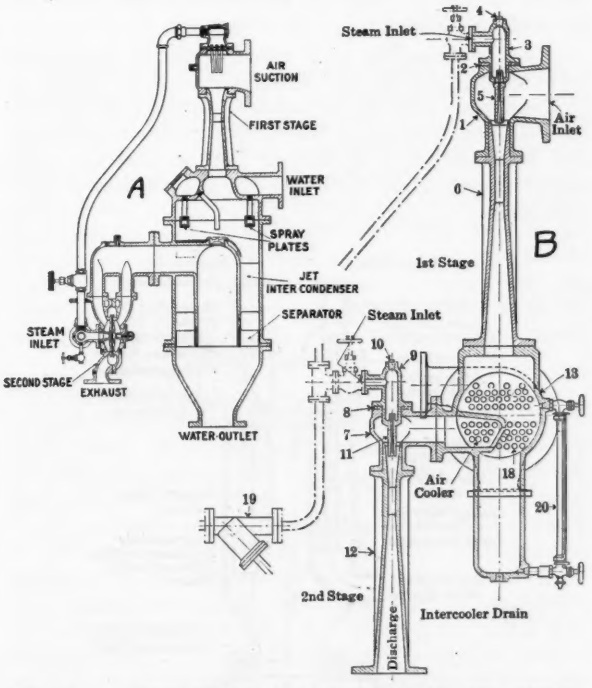



FIG. 2. A. TWO-STAGE JET PUMP WITH JET INTERCONDENSER AND B, TWO-STAGE EJECTOR WITH SURFACE INTERCONDENSER

### Multiple Units Used for Increased Efficiency

Construction details vary greatly among the various manufacturers. Some use multiple jets as in Fig. 1A, others use single jets as in Fig. 2B while one manufacturer uses a radial diffuser as shown in the second stage of Fig. 2A. A typical installation is shown in Fig. 6. This is a two-stage twin unit, that is, both the first and second stages are in duplicate so that if the air leakage is small one of the jets can be shut off. In modern stations, little air enters with the steam, practically all the air removed entering through leaks in the shell or piping.

Some stations are even using triple or quadruple units so that the steam consumption can be regulated in accordance with the air leakage. Steam consumption depends upon the size of the nozzles and steam pressure and is independent of the air flow so that the only means of controlling the steam flow is by means of multiple units.

Some of the larger stations are now using three-stage ejectors because of the greater economy. This increased economy is evident from Fig. 7 showing the capacity of two and three-stage units using the same amount of steam. This economy is more evident at high vacuums; for instance, at 29. in. the three-stage will handle 1½ times as much air as the two-stage; at 29.4 in., it will handle 2½ times as much while at 29.6 in. it will handle almost 6 times as much.

Vacuum pumps of this type are used with barometric and jet condensers as well as with surface condensers but due to the air dissolved in circulating water the air pump capacity for a barometric or jet condenser should be about twice that of a surface condenser of the same steam capacity. Selection of the proper

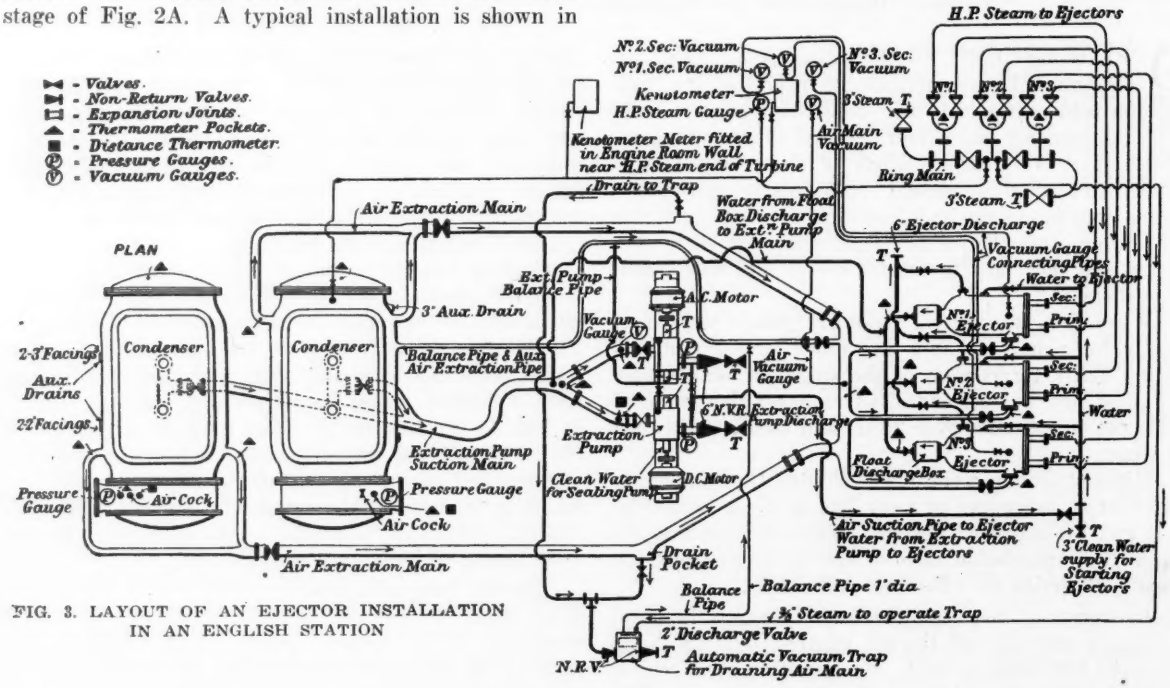



FIG. 3. LAYOUT OF AN EJECTOR INSTALLATION IN AN ENGLISH STATION

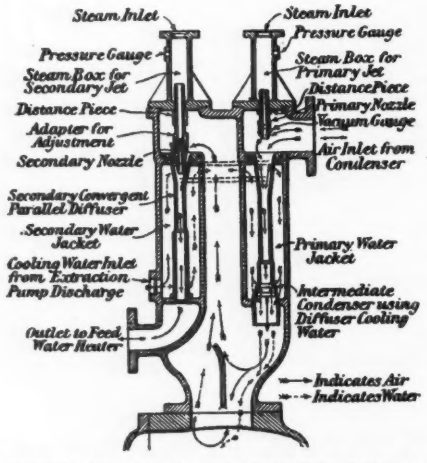



FIG. 4. CROSS SECTION OF AN ENGLISH EJECTOR WITH JET INTERCOOLER, AS USED IN FIG. 3

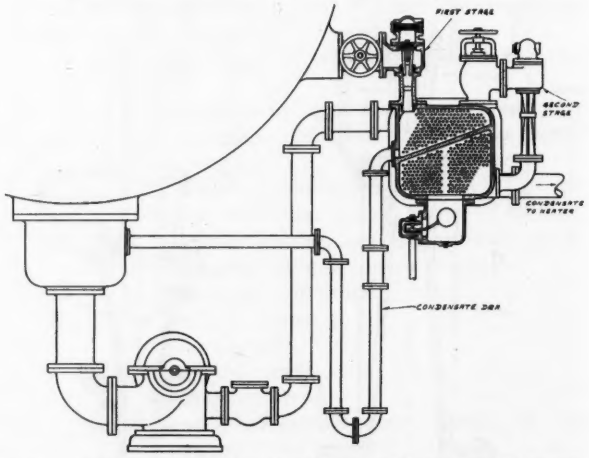



FIG. 5. TYPICAL INSTALLATION OF TWO-STAGE VACUUM PUMP WITH INTER AND AFTERCONDENSER USING CONDENSATE FROM THE CONDENSER AS THE COOLING MEDIUM

size for a given condenser is largely a matter of experience and arbitrary selection.

As mentioned before, with good feedwater conditioning little air comes in with the steam and it is generally thought that there is little reason why the air removal from a 50,000-kw. unit should be any greater than from a 10,000-kw. unit. Practically, however, there are more joints in the larger shell and piping and as a rule the vacuum carried is higher so that increased leakage does occur. Large units are always equipped with twin or triple ejectors, however, so that when the air leakage is reduced, the steam consumption can be cut down in proportion.

MOST INSTALLATIONS USE A PRESSURE OF AROUND 135 LB.

Data for the selection of an air pump should include:

1. Quantity of air to be handled, expressed preferably as cubic feet of free dry air per minute or, if this is not available, the size and type of condenser and the steam flow in pounds per hour so that an approximation of the air leakage may be made by the manufacturer.

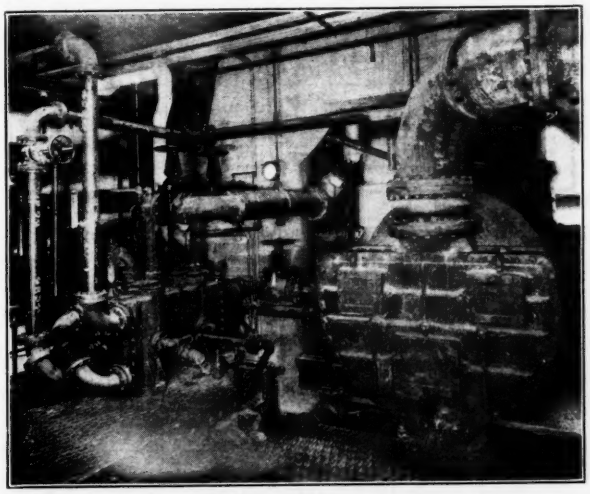


FIG. 6. INDUSTRIAL INSTALLATION OF A TWIN-UNIT, TWO-STAGE PUMP FOR CONDENSER SERVICE

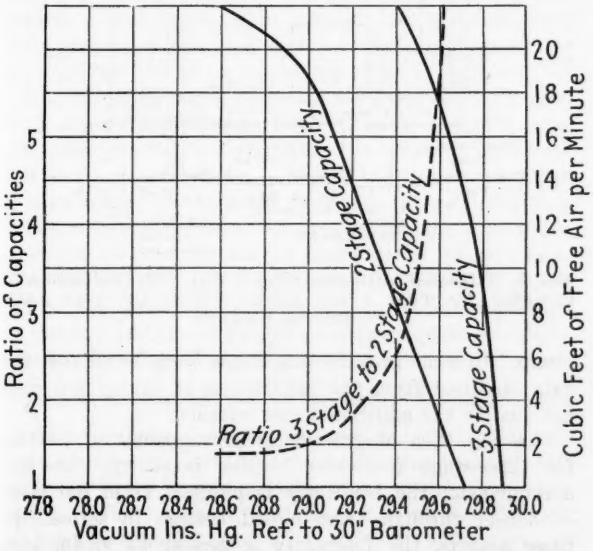

Ratio of Capacities
Cubic Feet of Free Air per Minute
2 Stage Capacity
2 Stage Capacity
3 Stage Capacity
Ratio 3 Stage to 2 Stage
27.8 28.0 28.2 28.4 28.6 28.8 29.0 29.2 29.4 29.6 29.8 30.0
Vacuum Ins. Hg. Ref. to 30" Barometer

FIG. 7. COMPARATIVE CAPACITY CURVE OF A TYPICAL TWO AND THREE-STAGE JET PUMP USING THE SAME AMOUNT OF STEAM

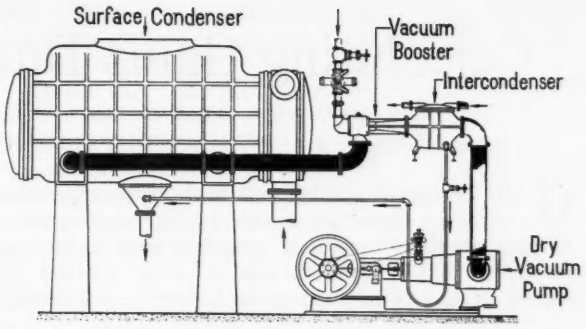



FIG. 8. TYPICAL ARRANGEMENT OF A SINGLE-STAGE JET PUMP USED AS A BOOSTER OR AUGMENTOR FOR INCREASING THE CAPACITY OF INSTALLED EQUIPMENT

2. Vacuum required or desired.

3. Temperature and source of the water available for the inter and after-condensers.

4. Steam pressure and temperature available for operating the jets.

Practically all types are built for an operating steam pressure of between 100 and 150 lb.; as a rule, this steam is obtained by throttling from the main steam line although occasionally in high pressure plants extracted steam is used.

For cooling water, condensate is generally used although an outside source should be provided for starting or for periods of light loads when the supply of condensate is insufficient. A few of the larger stations use outside water exclusively but this is not common practice. For insuring adequate cooling water at all loads, two general methods are used: bypassing some of the condensate back to the condenser so as to cool it while flowing over the cool tubes or recirculating condensate from the surge tank back to the condenser hotwell.

Figure 8 is an interesting application of single-stage ejector known as a booster or augmentor. The ejector acts as the first stage of the air pump, removes the vapor from the condenser, cools it in the intercooler and delivers it to the regular vacuum pump. As the second-stage pump handles only cooled noncondensible gases and receives them much denser than they were at the condenser inlet, its efficiency is considerably increased and an increased vacuum results. Ejectors for this purpose are often designed to operate at low pressure, using the exhaust steam from the other vacuum pump.

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FOR THE PURPOSE of rapidly comparing the fineness of coal below 200-mesh, the Jackson turbidimeter can be adopted. This instrument measures the light hiding or dispersing power and emphasizes the effect of the finer particles.

A specified weight of 200 gr. of coal should be heated to 105 deg. C. in about 25 c.c. of an oil mixture consisting of 11 parts kerosene and 1 part lubricating oil. The oil and coal mixture should be cooled a few degrees and diluted to exactly 150 c.c., being kept well mixed while pouring. The depth of liquid needed to obscure an electrically lighted x slot in the bottom of the tube is taken as an indication of the fineness. The less the depth the finer is the coal.

# Calculating Gains Due to Feedwater Heating

THE ADVANTAGES AND DISADVANTAGES OF CASCADING THE CONDENSATE TO THE CONDENSER AND CALCULATION OF GAINS DUE TO THREE-STAGE HEATING. BY R. L. REYNOLDS*

GAIN IN EFFICIENCY obtainable with single-stage extraction from the main turbine for feedwater heating when the turbine is operating with steam conditions of 300 lb. gage throttle pressure, 200 deg. F. superheat and 29 in. vacuum, is 5.9 per cent when the heater condensate is pumped into the main feed line on the boiler side of the heater.

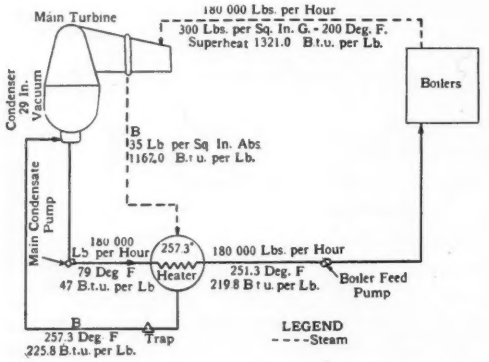


FIG. 1. DIAGRAMMATIC ARRANGEMENT OF SINGLE STAGE HEATING WHERE CONDENSATE IS CASCADED TO THE CONDENSER

If, instead of this arrangement, the heater condensate were cascaded through a trap into the main condenser, a slightly poorer performance would be obtained. To illustrate this, make the same assumptions as before, as follows:

| | |
|---|---|
| Throttle pressure | 300 lb. per sq. in. gage |
| Throttle superheat | 200 deg. F. |
| Exhaust vacuum | 29 in. (referred to a 30 in. barometer). |
| Internal Rankine cycle efficiency | 80 per cent |
| Pressure at bleeder point | 35 lb. pressure abs. |
| Steam flow to throttle | 180,000 lb. per hr. |

With these assumptions, the heat content of the steam at the bleeder point is found to be 1167.0 B.t.u. per lb., the B.t.u. turned into work between the throttle and the bleeder point 154.0 B.t.u. per lb. and between the bleeder point and the exhaust 200.4 B.t.u. per lb. The temperature of the feedwater leaving the heater will be 251.3 deg. F. with a heat of the liquid of 219.8 B.t.u. per lb. The temperature of the heater condensate will be 257.3 deg., with a heat of the liquid of 225.8 B.t.u. per lb. A diagram of this arrangement is shown in Fig. 1.

Equating the amount of heat entering the heater to that leaving the heater, the following equation, in which $B$ equals pounds of steam an hour, will be obtained:

$$1167.0\ B + 180{,}000 \times 47 = 225.8\ B + 180{,}000 \times 219.8$$

gives

$$B = 33{,}060 \text{ lb. per hr.}$$

In order to obtain the load output of the unit, we proceed as indicated in Table I. The heat consumption of the unit can be obtained as follows:

| | Flow Lb. per Hr. | Heat Content B.t.u. per Lb. | B.t.u. per Hr. |
|---|---|---|---|
| Steam from boilers | 180,000 | 1321.0 | 237,400,000 |
| Feedwater to boilers | 180,000 | 219.8 | 39,580,000 |
| Heat absorbed by unit | | | 197,820,000 |

$$\text{B.t.u. per kw-hr.} = \frac{197{,}820{,}000}{15{,}750} = 12{,}560$$

Heat consumption of the turbine when operating with single-stage heating and with the steam which is condensed in the heater pumped into the main feed line was shown in a previous article to be 12,340 B.t.u. per kw-hr. This means that a loss of 1.8 per cent is suffered because of the omission of the heater condensate pump.

TABLE I. CALCULATIONS FOR SINGLE STAGE BLEEDING

| | | |
|---|---|---|
| Steam to throttle lb. per hour | 180 000 | 180 000 |
| Steam bled lb. per hour | 0 | 33 060 |
| Steam flow through group lb. per hour, $W$ | 180 000 | 146 940 |
| Work done in B.t.u. per lb, $H$ | 154.0 | 200.4 |
| Output (internal horse-power) $\frac{W \times H}{2545}$ | 10 880 | 11 570 |
| Total output (internal horse-power) | 22 450 | |
| Mechanical loss (horse-power) | 230 | |
| Brake horse-power | 22 220 | |

Assuming a generator ezciency of 95 percent
Kw output = 22 220 × 0.095 × 0.746 = 15 750

Part of this loss is offset because of the reduction in auxiliary power obtained with the omission of this pump. In some installations, it has been found that the gain obtained from the installation of this pump does not justify the additional cost entailed.

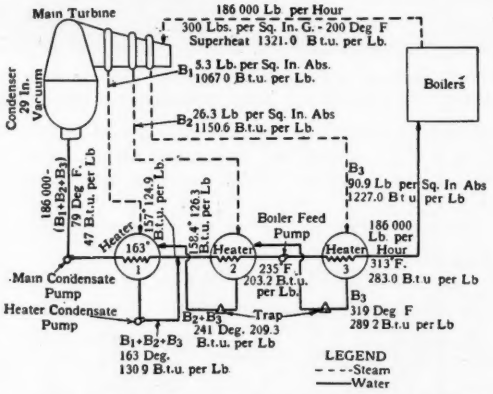
Main Turbine
186 000 Lb per Hour
300 Lbs. per Sq. In. G. - 200 Deg F Superheat 1321.0 B.t.u. per Lb.
Boilers
Condenser 29 In. Vacuum
B1 53 Lb. per Sq. In. Abs. 1067 0 B.t.u. per Lb.
B2 26.3 Lb per Sq. In. Abs 1150.6 B.t.u. per Lb.
B3 90.9 Lb per Sq. In Abs 1227.0 B t u per Lb
186 000 - (B1+B2+B3) 79 Deg. F. 47 B.t.u. per Lb
Heater 1
163°
157° 124.9 B.t.u. per Lb.
158.4° 126.3 B.t.u. per Lb
Heater 2
Boiler Feed Pump
235° F 203.2 B.t.u. per Lb.
Heater 3
186 000 Lb. per Hour
313° F. 283.0 B.t u per Lb
Main Condensate Pump
Heater Condensate Pump
B2+B3 241 Deg. 209.3 B.t.u. per Lb
Trap
B3 319 Deg F 289 2 B.t.u per Lb
B1+B2+B3 163 Deg. 130 9 B.t.u. per Lb
LEGEND
----Steam
——Water

FIG. 2. THREE-STAGE HEATING WITH THE CONDENSATE PUMPED TO THE FEED LINE AHEAD OF THE LOW PRESSURE HEATER

In Fig. 2, a diagrammatic arrangement of heaters for three-stage feedwater heating is shown. In this arrangement, the feedwater is pumped from the main condenser through three closed heaters in series. In these heaters, the feedwater is heated by steam bled from the turbine. The steam bled to the highest temperature heater, the No. 3 heater, is condensed in this

*Turbine Engineering Dept., So. Philadelphia Works, Westinghouse Elec. & Mfg. Co. From an article in the Electric Journal. The first article on this subject by Mr. Reynolds appeared in Power Plant Engineering, July 1, 1929, page 739.

heater and is then cascaded through a trap into the steam space of the adjacent heater of a lower pressure. Part of this condensate, because of the lower pressure, is evaporated and flashes into steam, thus decreasing the amount of steam necessary to be bled from the turbine at this point.

The combined steam condensed in the intermediate temperature, or No. 2 heater, is in turn cascaded through a trap to the steam space of the low temperature, or No. 1 heater, in which part of it flashes into steam. The combined heater condensate thus accumulated in the No. 1 heater is pumped into the main feed line on the boiler side of this heater. This condensed steam could be trapped back to the main condenser, but because of the relatively large proportion of steam bled, the addition of a heater condensate pump is amply justified.

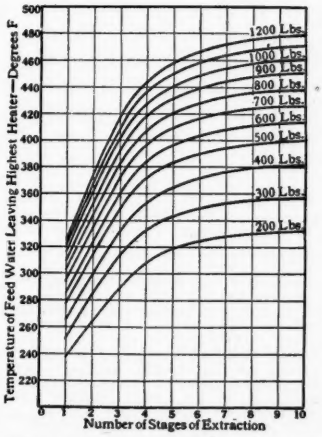


FIG. 3. AFTER FOUR STAGES, THE GAIN PER HEATER DECREASES

When the condensate from each heater is trapped back to the next lower heater, a considerable portion of the heating done in the lower heater is done by the condensate from the higher heaters. This means that the amount of steam bled to the lowest temperature heater is smaller than it would be if the steam condensed in each heater were pumped into the main feed line. As the steam bled from the lowest bleeder zone has done more work in the main turbine than steam bled from the higher zones, it can be more economically used for heating the feedwater than steam at a higher pressure. Because of this, a small gain in heat consumption can be obtained by pumping the condensed steam in each heater to the main feed line on the boiler side of the respective heater, thus increasing the proportion of steam bled to the lowest temperature heater; however, except for large installations, the increased power and higher cost of installation and maintenance entailed by the two additional pumps more than offset the slight gain in efficiency obtained.

### Condensate Not Heated to Saturation Temperature

As a concrete example, to show the method of calculating the heat consumption of a turbine when operating with three stages of extraction, assume the same unit as before; namely, a 20,000-kw. unit operating at its most economical load of 16,000 kw. with steam of 300 lb. gage pressure and 200 deg. F. superheat at throttle, and exhausting at a vacuum of 29 in. In this case, a steam flow of 186,000 lb. per hr. to the throttle is assumed, with the feedwater heated to a final temperature of 313 deg. F.

Theoretically, the temperature to which the feedwater should be heated can be determined by dividing the rise in saturation temperature from condenser pressure to boiler pressure by a number one greater than the number of stages of feedwater heating and then subtracting this value from the saturation temperature corresponding to the boiler pressure. This rule is based

TABLE II. TEMPERATURES AND PRESSURES IN A THREE-STAGE HEATING SYSTEM

| Heater number | 1 | 2 | 3 |
|---|---|---|---|
| Temperature entering heater—Deg. F. | 79 | 157 | 235 |
| Temperature leaving heater—Deg. F. | 157 | 235 | 313 |
| Saturation temperature in heater—Deg. F. | 163 | 241 | 319 |
| Saturation temperature in turbine—Deg. F. | 165 | 243 | 321 |
| Pressure in turbine—Lb. absolute | 5 3 | 26.3 | 90.9 |

on a stage efficiency of 100 per cent in the turbine and a terminal difference of zero degrees in the heaters. This fact can be determined by making these assumptions of stage efficiency and terminal difference and calculating certain points with different final feed temperatures.

In this instance, the condenser pressure is 1 in. of mercury abs. and the boiler pressure 315 lb. per sq. in. abs. The saturation temperatures for these pressures at 79 deg. and 422 deg. respectively, making a temperature rise of 343 deg. With three-stage heating, this temperature rise should be divided by four, which gives 86 deg. Subtracting this value from 422 deg., the final feed temperature becomes 336 deg.

In actual practice, the most efficient final feed tem-

TABLE III. WORK CALCULATIONS FOR THREE-STAGE FEED HEATING

| Inlet pressure—lb. per sq. in. absolute | 300 | 90.9 | 26.3 | 5.3 |
|---|---|---|---|---|
| Outlet pressure—lb. per sq. in. absolute | 90.9 | 26.3 | 5.3 | 0.49 |
| Inlet B.t.u., entropy = 1 633 | 1321.0 | 1203.5 | 1108.0 | 1003.5 |
| Outlet B.t.u., entropy = 1.633 | 1203 5 | 1108.0 | 1003.5 | 878.0 |
| Adiabatic heat drop, B.t.u. per lb. | 117.5 | 95 5 | 104 5 | 125.5 |
| Efficiency | 0 8 | 0.8 | 0.8 | 0.8 |
| Work done, B.t.u. per lb. | 94.0 | 76 4 | 83.6 | 100.4 |

perature is somewhat less than the value obtained by this method. With a stage efficiency of 80 per cent and a terminal difference of 6 deg. F., the temperature to which the feedwater should be heated in order to obtain the maximum gain from feed heating will be as shown in Fig. 3, the temperature for the present case being 313 deg. F.

With equal temperature rises over the three heaters, the temperatures leaving the heaters and the stage pressures in the turbine, will be as shown in Table II. The same assumptions for terminal difference and pressure drop in heater lines as for single-stage heating are adopted, i.e., a pressure drop of 2 deg. F. between turbine and heater and a terminal difference of 6 deg. F. between heater and leaving feedwater temperatures.

With an internal efficiency of 80 per cent, the work done in each of the groups of the turbine will be as indicated in Table III. The actual heat content of the steam at the bleeder points is, therefore:

1321.0 — 94.0 = 1227.0 B.t.u. per lb. at 90.0 lb. per sq. in. abs.
1227.0 — 76.4 = 1150.6 B.t.u. per lb. at 26.3 lb. per sq. in. abs.
1150.6 — 83.6 = 1067.0 B.t.u. per lb. at 5.3 lb. per sq. in. abs.
1067.0 — 100.4 = 966.6 B.t.u. per lb. at exhaust.

The heat contents of the steam and water will be as shown on Fig. 2.

Condensate through the two highest heaters will be the same as the steam flow to the throttle, or 186,000 lb. per hr. whereas the condensate through the lowest temperature heater will be the same as the steam flow to the condenser, or the throttle flow minus the steam extracted. The heat balance equations, designating the amounts of steam bled to the high, intermediate and low temperature heaters as $B_3$, $B_2$ *and* $B_1$ respectively, will be as follows:

$$1227.0\ B_3 + 186{,}000 \times 203.2 = 289.2\ B_3 + 186{,}000 \times 283.0$$

$B_3 = 15{,}840$ lb. per hr.

$$1150.6\ B_2 + 186{,}000 \times 126.3 + 15{,}840 \times 289.2 = 209.3\ (B_2 + B_3) + 186{,}000 \times 203.2$$

$B_2 = 13{,}830$ lb. per hr.

$$1067.0\ B_1 + (186{,}000 - 15{,}840 - 13{,}830 - B_1)\ 47 + (15{,}840 + 13{,}830)\ 209.3 = (186{,}000 - 15{,}840 - 13{,}830 - B_1)\ 124.9 + 130.9\ (B_1 + 15{,}840 + 13{,}930)$$

$B_1 = 9720$ lb. per hr.

The output of the turbine when operating with

TABLE IV. METHOD OF CALCULATION OF THE TURBINE OUTPUT WHEN BLED AT THREE POINTS

| | | | | |
|---|---|---|---|---|
| Steam to throttle, lb. per hour | 186 000 | 186 000 | 186 000 | 186 000 |
| Steam bled, lb. per hour | 0 | 15 840 | 29 670 | 39 390 |
| Steam through group, lb. per hour, $W$ | 186 000 | 170 160 | 156 330 | 146 610 |
| Work done in group, B.t.u. per lb., $H$ | 94.0 | 76.4 | 83.6 | 100 4 |
| Output (internal horse-power) $\frac{WH}{2545}$ | 6870 | 5110 | 5130 | 5780 |

| | |
|---|---|
| Total horse-power | 22 890 |
| Mechanical loss horse-power | 230 |
| Brake horse-power | 22 660 |

Assuming a generator efficiency of 95 percent,
Kw output = 22 660 × 0.350 × 0 746 = 16 060

three stages of extraction is, therefore, as shown in Table IV and the heat consumption of the unit will be:

| | Flow-Lb. per Hour | B.t.u. per Lb. | B.t.u. per Hour |
|---|---|---|---|
| Steam from boilers | 186,000 | 1321 | 245,600,000 |
| Feedwater to boilers | 186,000 | 283 | 52,600,000 |
| | | | 193,000,000 |

$$\text{B.t.u. per kw-hr.} = \frac{193{,}000{,}000}{16{,}060} = 12{,}010$$

Heat consumption with straight condensing operation was calculated in the first article as 13,030 B.t.u. per kw-hr. Therefore the gain over straight condensing operation equals

$$\frac{13{,}030 - 12{,}010}{13{,}030} = 0.0783 \text{ or } 7.83 \text{ per cent}$$

The foregoing paragraphs have described the method employed to calculate the gain obtainable with single-stage and three-stage extraction. By using the same method, the gain from any desired number of stages of extraction may be determined.

### Effect of Operating Conditions on Feed Heating

All of these calculations have been based on steam conditions of 300 lb. per sq. in. gage pressure and 200 deg. F. superheat at the turbine throttle with an exhaust vacuum of 29 in. These conditions are quite representative of the present installations, although the tendency is to go to much higher pressures and temperatures. Of course, the steam conditions employed for various power plants will depend upon the conditions peculiar to each installation and will vary between wide limits. Because of this wide variation in steam conditions, the effect of throttle pressure and temperature and exhaust vacuum on the gain realized from stage heating will be shown in a later article.

# Cost of Generating and Distributing Power

COST OF GENERATING power at the switchboard of a typical hydroelectric system is only 7 per cent of the final cost to the lighting consumer, according to a report on the proposed Kennett Reservoir Development in California recently issued by Lester S. Ready, consulting engineer. His analysis of the relative cost of electric service at different points in the power system is based on a study of one of the largest enterprises in the state, in which water power plants are reinforced by a standby steam installation necessary to insure continuous service to consumers in the event of diminished stream flow or of unforeseen emergencies in the hydroelectric plants or in transmission lines. Distribution of items in the cost of service is shown in the following table:

COST OF ELECTRIC SERVICE, PER KILOWATT-HOUR USED BY LIGHTING CONSUMERS

| | | |
|---|---|---|
| Cost of hydroelectric generation at power house | 0.37c or | 7.0% |
| Cost of transmission of this power from the hydro power house to the city substation, of stepping it down for use on the city distribution lines and of the energy lost between power house and substation | 0.45c or | 8.5% |
| Cost of operating and maintaining a steam "stand-by" plant as insurance against low water in the hydro plant's reservoir and against breakdowns in the hydro plant's machinery or transmission lines | 0.29c or | 5.5% |
| Cost of distributing this power to residences | 1.64c or | 31.0% |
| Costs arising from the individual consumer as such (operating and maintaining his meter and the services leading to his house from the general distribution lines; reading his meter; rendering bills; answering calls for blown fuses and "trouble" of all sorts) | 1.95c or | 36.8% |
| General "Overhead" expenses, borne by all classes of users (including Federal taxes) | 0.20c or | 3.7% |
| Total | 4.90c or | 92.5% |
| State Taxes | 0.40c or | 7.5% |
| Total Cost of Lighting | 5.30c or | 100% |

A striking feature of Mr. Ready's study is the much lower inherent cost of supplying the consumer of large amounts of power. Where the cost of serving the lighting consumer is dominated by the expenses of distribution and of individual "consumer costs" these charges are relatively very small in the case of the wholesale user. As a result, his analysis shows the average cost for retail power as 1.57 cents and for wholesale power as 0.93 cents per kilowatt-hour sold. In this last figure, the cost of hydroelectric generation makes up 40 per cent of the total and the cost of its transmission and transformation in the main substations (together with the cost of the electricity lost in these processes) make up another 40 per cent. The balance, comprising all the items which go to make up 84½ per cent of the expenses of residential service, actually form less than 20 per cent of the cost of serving the wholesale user of electric power.

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THE BRITISH THERMAL UNIT is the standard of heat measurement in this country. It is defined as the heat required to raise one pound of water one degree F., or, more correctly as 1/180 of the heat required to raise one pound of water from 32 to 212 deg. F.

Morrough P. O'Brien*
Discusses

# *Scandinavian Hydroelectric Development* and the part played in it by MODEL TESTS

SWEDEN AND NORWAY have relatively large amounts of undeveloped water power and only small deposits of coal and other combustible materials, hence the development of hydraulic power has gone ahead in these countries with rapid strides, especially since the war. Although Polish coal is obtainable in Sweden at low cost, it is usually cheaper to develop the water power than to generate primary steam power.

A few years ago, it seemed that the efficiencies of all types of hydraulic turbines had reached a maximum but they have continued to increase by small but perceptible amounts. Among the Scandinavian manufacturers, this progress has been due chiefly to the intensive use of tests on small models as a basis for design.

### Tests of Pelton Turbine Models

In the field of impulse or Pelton turbines, the use of model testing has shown some remarkable results. For the Norwegian plant at Nore, at which the turbines have recently been installed, the complete installation, including nozzles, buckets, deflector and discharge section, was studied by means of a model to a scale of 1:5 both at the laboratory of J. M. Voith at Heidenheim, Germany, and at the Pelton turbine laboratory maintained jointly by Kvaerner Bruk and Myrens Verkstad in Oslo. These units will have two wheels each having two nozzles and will develop 36,000 hp. at 300 r.p.m. under an average head of 343 m. (1130 ft.). The guaranteed efficiency is 87 per cent at 0.8 full load but the model tests gave 90 per cent for the Norwegian design and 89 per cent for the Voith runner. It is expected that the efficiency of the prototype will be one or two per cent greater than that of the model but no formula for predicting such an increase in efficiency has been developed for Pelton wheels.

It is known that the angle between two nozzles supplied by a common pipe line should be small, to prevent a whirling motion of the stream as it strikes the bucket. In the model tests, an important object was to determine how small this angle could be without causing interference of the jets. Regulation of the Norwegian turbines is accomplished by moving a deflector into the jet and moving the needle slowly into the position for steady flow under the new load conditions. Accordingly, the model experiments were used to determine the force required to move the deflector into the jet. The buckets for the Norwegian runners have a rather blunt splitting edge and rounded sides, while the German buckets are deep and have a sharp splitting edge and straight sides.

### Costs and Profits of Model Tests

Another example of the results that may be obtained by careful model experiments is the Norwegian plant at Rjukan. The original turbines gave an efficiency of only 80 per cent, therefore the owners commissioned Verkstaden, Kristinehamn, Sweden, to rebuild them on the basis of a fixed price for attaining the guaranteed efficiency and a bonus for each fraction of a per cent above the guarantee. As a result of extremely careful studies, this company brought the efficiency up to 89 per cent and received a bonus of approximately $35,000.

Considering the financial side of the experiments on the turbines for the plant at Nore, the cost of the project will be about $2,700,000 and, assuming that the turbines attain an efficiency of 90 per cent, the cost for each per cent of efficiency is $30,000. Since the average impulse turbine will show an efficiency of between 85 and 88 per cent, the model tests really added between $60,000 and $150,000 to the value of the station and the experiments themselves cost perhaps one-tenth of the latter figure. Such model tests are also valuable in that they insure the manufacturers against the payment of heavy penalties for failing to fulfill the guarantee.

In the design of the Francis turbines for the recently completed plant of the City of Oslo at Solbergfos, 50 model runners were tested at the Hydraulic Laboratory of the Technical University of Trondhjem. The cost of these experiments was about $15,000 but the efficiency attained by the prototype, 94.5 per cent, was sufficiently high so that the bonus paid for the experiments and left a handsome profit for the manufacturer. The above efficiency was accepted as correct by the engineers in charge of the plant because of the steadily upward trend of turbine efficiencies but it is somewhat open to question, due to the method of measuring the water quantity. These units develop 12,500 hp. at 150 r.p.m. under a head of 72 ft.

### Propeller Runner Development Has Depended Largely on Models

In the development of high specific speed propeller type turbines, the use of models has played an even more important part than in the development of the other types. The Kaplan and Lawaczeck turbines at

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Lilla Edet have been discussed extensively in the technical press but it does not seem to be generally appreciated that, previous to their construction for this station, both of these types were practically unknown and untried and the decision to employ them resulted entirely from model experiments. The Kaplan turbine was examined after 21 mo. of service and the blades and the blade operating mechanism were found to be in perfect condition. The examination was made only because the manufacturer's guarantee expires at the end of two years. The leakage of oil from the boss of the runner was about 10 liters (2.6 gal.) per day during the warmest weather and practically none in winter. The leakage in warm weather has been reduced to practically nothing by minor changes in the packing.

Model experiments have resulted in changes in the original design of the blades and the boss of the Lawaczeck runner, giving it greater part-load efficiencies and greater overload capacity. The Nydquist and Holm Co. of Trollhattan has been working for some years on propeller turbines and has just begun to offer them for sale. Professor Dahl of the Technical University, Stockholm, has also developed a propeller runner having fixed radial blades bent up at the tips to reduce the leakage through the clearance spaces. The latter type was being considered for the Perak Power Plant in India. Tests on a 545-mm. model (21.4 in.) at Myrens Verkstad in Oslo showed a maximum efficiency of 89 per cent at full load and, in addition, a very good part-load efficiency. This turbine is now being built by The Finshyttan Co. of Finshyttan, Sweden.

### Cavitation and Pitting Studies on Models

As the problem of cavitation and runner pitting is of particular importance in the design of high specific speed runners, because of the relatively high discharge velocities from such runners and, since the elevation of the runner at which pitting will occur cannot, at present, be predicted from theoretical considerations, model experiments are made by Verkstaden, Kristinehamn, to determine the maximum permissible suction head for each runner. It has been found that this head is about the same for both the model and the prototype. The turbine laboratory at the Technical University, Stockholm, where the Dahl runner was developed, is also equipped for cavitation experiments.

Since the Kaplan type of high specific speed turbine with adjustable blades is particularly suited to use in isolated stations having but one or two units, Verkstaden, Kristinehamn, the licensee for this type in Sweden, is experimenting with a runner under a 22-m. (72.2 ft.) head. This runner, which has blades of four different materials, has been in operation under actual working conditions for over a year but the results have not yet been published. The purpose of these experiments is to adapt the Kaplan design to the usual range of heads for Francis runners.

The Lanforsen Power Plant, located on the Dalalven between the Untra plant of the City of Stockholm and the Alvkarleby plant of the Royal Board of Waterfalls, will be operated jointly by the City of Stockholm owning two-thirds and the Snadviken Iron Works owning one-third of the power. This development will consist of three dams, one of which will be integral with the power house. For the present, two Kaplan turbines with a total capacity of 14,000 kw. will be installed.

Of the other stations, 17,000 hp. will be developed at Krongfors under a 15.5-m. head, 30,000 hp. at Munkfors on the Klaralven by means of two Kaplan turbines, 30,000 hp. at Alvestra Storfors on the Dalalven and 44,000 hp. at Karseforsen on the River Lagan.

### Hydraulic Structures Laboratory

One of the first important model experiments made in Sweden was a study of the locks operated by the Board of Waterfalls at Sodertelje. Sometime after this, a laboratory for studies of hydraulic structures was established at the Royal Technical University at Stockholm. In its equipment and methods, this laboratory is similar to the German hydraulic laboratories at Karlsruhe, Dresden, Berlin and Munich. Since the completion of this laboratory in 1920, model experiments have been made in connection with the water power plants at Lilla Edet, Volhov, Hammarforsen, Sikfors, Trollhattan and others, besides studies of the currents in the harbor of Stockholm, the discharge capacity of dams, of means of dissipating energy at the foot of dam and of general hydraulic problems.

During the past year two interesting model experiments have been made in this laboratory. The first series of experiments, completed in the fall of 1927, was a study of the Perak Power Plant now under construction in India. As the design included some new and untried features, the designing engineers, Vattenbyggnadsbyron of Stockholm, wished to have the conditions of flow checked by model studies. Accordingly, the pressure on the sector-gates, the operation of the bottom outlets, the possibility of erosive velocities below the apron and the surging of the water within the hollow dam were investigated by models to scales of 1:36, 1:52 and 1:96. These model studies resulted in important changes in the original design, many of which reduced the necessary amount of construction while others eliminated features that would have been undesirable and even dangerous.

### Studies of Erosion

After the completion of the experiments for the Perak developments, the Swedish State Railways requested that a model of the Gide River at the bridge on the main line north to Narvik, be constructed and tested to determine means of preventing further erosion of the pier on the right bank, which was seriously undermined during the spring of 1927. After studying the effect of various locations of spur dykes and of deepening the river bed, it was found that the protective layer of 5-t. granite blocks, which had been placed around the pier during the winter, would change the manner of flow so that no further erosion would occur.

In conclusion, it seems that the present trend in both the mechanical and structural branches of hydraulic engineering in Scandinavia is towards the combination of theoretical studies with laboratory experiments on small models. Although there is still some distrust of the result of model experiments, the most important consulting engineers and manufacturers regard them as an invaluable check on the design, eliminating to a great extent the uncertainty which is involved in the computation of all but the most simple hydraulic problems.

## Sandstone as Filtering Material for Open Heaters

IN MANY OPEN heaters, coke is used with other material such as excelsior and burlap as a filtering agent. One method for placing such material, where the flow of water in the heater is downward, is to spread burlap over heavy iron plates which have their entire surface drilled or punched with many ⅜ or ½-in. holes, each covering plate being made in several parts to facilitate handling. A layer of coke is placed on top of the burlap and more burlap is spread over this layer, then a layer of excelsior is spread on top of the upper sheet of burlap. Iron plates, duplicates of the ones described are placed on top of the excelsior.

In cleaning out such a chamber in a heater, the work can be done in a short time, if clean material is at hand for recharging. The oily and dirty coke and the burlap can be cleaned by boiling them in water to which soda has been added. They should then be stored to be reused at the next cleaning. Fresh excelsior is used at each cleaning.

When coke is used, a certain amount of fine coke will continue to be washed or worn off and may find its way to the feed pump and cause valve trouble. Some engineers assert that this coke dust will find its way through the excelsior and burlap; only a small percentage of it, I believe, will actually do so.

Some men install separate settling chambers beyond the heater to catch all of the heavy sediment which may be in the water supplying the heater. Animal charcoal is much superior to coke as a filtering medium but its cost is too great for common use.

One man, who lived near a sandstone quarry, had the idea of trying sandstone instead of coke for filtering material. He broke a quantity of the stone into pieces of the desired size and then thoroughly washed this broken stone, using a high-pressure stream of water from a hose and turning the stones over repeatedly while they were being washed.

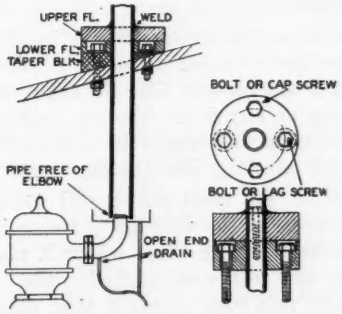
This washed sandstone was substituted in the heater for the usual filtering material. It gave excellent service, absorbing oil and other substances out of the water and so far as could be discovered no sand from the sandstone material was carried over from the surfaces. The stone could be reused repeatedly.

Uffington, Ont., Can. JOHN THORN.

## Discharge Pipes from Safety Valves Should Be Drained

EXHAUST PIPES from safety valves, according to best practice, should be supported independently so that the safety valve itself carries no additional pipe. A method which has been found satisfactory for this service is shown in the sketch. Various forms of elbows are available for this purpose, the important point to remember being that the elbow should be well drained by an open ended drain.

Two blank flanges, at least twice the pipe diameter should be obtained. One of these should be drilled with just enough clearance to slip it over the pipe while the other can have ½ or ¾-in. clearance. The flange, with the small clearance should be welded to the pipe at the proper point while the other flange is fastened to the roof and made watertight with tin and pitch. If desired, a couple of bolts or lag screws can be used, as indicated, to clamp it into position after discharge pipe is centered over the elbow.




INSTALLATION OF SAFETY VALVE SHOULD INCLUDE DRAIN CONNECTIONS AT ELBOW AND AT LOWER END OF SAFETY VALVE DISCHARGE PIPE

On some roofs the lower flange is unnecessary, although it helps greatly in making the joint watertight. The easiest way to hold this flange in place is with two or three bolts. The holes should be counterbored as shown at C so that the heads come below the surface of the flange and therefore do not interfere with the flange which is welded to the pipe. If the roof slopes, a tapered block must be used between the flange and roof.

Brooklyn, N. Y. P. F. ROGERS.

## Smaller Impeller Diameter Reduces Centrifugal Pump Load

FROM SOME CAUSE or another, the motor selected to pull a centrifugal pump in a small city waterworks was too small and had always run abnormally hot due to excessive load. A new motor had to be bought or the load reduced on the existing motor, for it was only a matter of time until the overloaded motor would burn out.

The efficiency of the pump in this case was not of major importance so, after due consideration, it was decided to turn down the impeller to a slightly smaller diameter. This quite effectually reduced the load to the point where the motor could handle it, but any one trying this method should go carefully, as it only takes a little bit off at this point to make a considerable difference in the load and also the efficiency of the pump.

Coffeyville, Kan. EARL PAGETT.

Editor's note: If there is plenty of head, the method proposed above may be used. Cutting down the impeller blades lowers the head and capacity curve and, of course, reduces the power required to operate the pump. On some types of pumps, it might cause thrust trouble because of excessive clearance between the impeller shroud ring and the plates.

## Home-made Cup Washers

ON PAGES 715 and 716 of the June 15 issue is a short article on forming cup washers without a special mold with which I do not agree.

Perhaps in an emergency it may be all right and necessary for the engineer to make a molded leather packing but I am certain that no engineer can make as good a cup or any other kind of packing as can a manufacturer who is completely equipped for doing such work, for anything like the same price.

For example, the mold shown will form a packing that will be weak at the very place where it should be strongest, namely, at the place where it makes a bend from the flat side to the cylindrical. The only way in which to make this edge stronger than other points is to "upset" the leather and make it thicker there than elsewhere. An ordinary mold won't do that.

After saying that, "only the very best leather stock procurable should be used for this purpose," the author goes on to say, "If the leather is hard and dry, it should be soaked longer in the warm water than if it is soft and pliable." This does not agree with the first statement because, if the very best leather stock procurable is used, it will not become hard and dry.

I have in mind one concern that uses $1800 worth of leather packings a year. The company has a first-class chief engineer in charge, who, I dare say, could make the packings himself or could have them made in his own town, if he felt that money would be saved that way. But he doesn't do it. He buys the packings from a first class manufacturer and finds that it pays to buy the best he can get.

The chances are that after a packing is made by the engineer it will not fit as well as would a factory-made packing. It will leak more. It will not last so long. It will be less efficient. In the end, the machine will be less economical, its usefulness will be impaired and considerable money will be lost all around.

I am not a believer in home-made products to compete with factory-made products. I enjoy making things myself and I do make things as a pastime but I do not make them in competition with regular manufacturers. It can't be done. I could turn out two disks and make a cup packing along the lines described but I wouldn't do it and use it in a machine regularly because I know that the packing would be poor in comparison with what I could buy from a first-class manufacturer.

Even in manufactured packings, there is a vast difference. I know of instances where one type of leather was replaced regularly every month. It was replaced that often because the engineer believed he was using the best packing that could be purchased. Imagine his delight when he found a better type of leather that now lasts a year instead of a month. All of which explains why I disapprove of using home-made products.

Newark, N. J. W. F. SCHAPHORST.

## Handy Friction Tape

WHEN IT IS necessary to adjust a nut or a screw in an almost inaccessible part of a small machine, a little friction tape is of great service. If the part can barely be reached by the fingers, the tip of the longer finger should be wound with a bit of electrician's friction tape and pressed against the nut.

When a small screw must be inserted in an almost inaccessible part, wrap one end of a piece of tape around the screw head and then around the end of the screwdriver which has been inserted in the slot of the head and is held there, then wind the tape along the screwdriver's blade and there will be no difficulty in inserting the screw if you are careful to keep the screwdriver in the slot.

Tape can best be kept in the tool box by putting it in an empty shoe polish box after it has been cleaned out. This, having a tight fitting cover, will prevent the tape from drying out and at the same time keep it clean.

When the ferrule slips off the handle of one of your hand tools, cut a small piece of tape and place it smoothly and evenly over the end of the handle; then slip the ferrule over the tape and drive it home. So treated, the ferrule may hold for many years.

If you have to tighten nuts on bolts which turn around during the process and the heads are hard to reach or hold with a wrench, just put one or two bits of friction tape under the bolt heads and there will be no more trouble in tightening them. When it is necessary to hold together pieces of metal which are slightly tapered and the clamps or vise jaws keep slipping off, place a bit of tape under each clamp foot or screw or between the vise-jaws and the tapered pieces and there will be no more slipping.

When a split pulley slips on its shaft, remove it and wind a single thickness of friction tape evenly and smoothly around the shaft and tighten the pulley in place and it will slip no longer. Tape wrapped around a center-punch, cold chisel or other tool that may have become smooth and "slick" through use will make the handling of such tools much more convenient and may

even prevent accident or damage which would result from slippage. Brushing the tape with shellac prevents the curling up of the edges of the tape. In using shellac, it must be allowed to dry thoroughly before the tool is used.

Tape wrapped around small bottles of eye water or other safety first supplies will almost completely insure against breakage. Tape will be found useful when laying out work on a metal surface as when a straightedge or steel square cannot be clamped to the surface. Two or three short pieces of tape placed between the work and the straightedge and two or three weights placed on it assures its lying securely in position while being used.

Occasionally it is found necessary comparatively to measure the circumference of the inside of a ring and the outside of the circular object upon which the ring is to be fitted such as in the case of a shrink fit. For this purpose, a traverse wheel is usually used but in its use it is difficult to prevent the wheel from slipping, in which case the value of the measurement is destroyed. Slippage of the wheel may be avoided by stretching a single layer of tape around the wheel and lap it a half inch to hold it securely.

Indianapolis, Ind. JAMES F. HOBART.

## Deposits Behind Commutators Result in Leakage

DEPOSITS OF COPPER, carbon and atmospheric dust collected at the back of the commutator and inside the armature are frequently troublesome. If they are in sufficient quantities, they will lead to electrical leakage and perhaps a burn-out.

Dust passes through the commutator riser bars, being drawn by the fanning action as the bars rotate; once behind the commutator, it settles on any surface which offers settling room. There is often a film of oil inside the armature and when the dust settles on this it forms a very adhesive mixture. In some machines, there are projecting surfaces on the inner vee ring and if dust collects around this ring it will soon cause electrical leakage. Frequent blowing out will minimize the trouble through this dust but some dusts, particularly dust moistened by oil, are very adhesive and may not be removed by blowing out.

Dust which collects comes from three sources: copper dust through wear on the commutator, carbon dust through wear on the brushes and atmospheric dust which comes from the atmosphere. When these three dusts are mixed together, they form a highly conducting mixture. The worst dust from this point of view is the dust produced by the wear of soft graphite brushes; these wear rapidly and the dust produced is soft and greasy and readily adheres to where it settles. Therefore these brushes should be used only under conditions of absolute cleanliness, the machine being regularly blown out and the brush rigging frequently cleaned.

Where absolute cleanliness cannot be assured, harder brushes which produce less dust should be used. The surfaces behind the commutator should be taped up so that there are no convenient settling places for the dust and all the surfaces should be given a coat of smooth insulating varnish.

Danger from dust may be prevented by taping up the spaces between the riser bars with muslin or similar material. This is open to the objection that it interferes with the passage of the ventilating air and may therefore lead to overheating. If this remedy is adopted, the armature should be carefully watched for its temperature rise when running and if this is found to be excessive the covering should be removed.

As the bulk of the dust is drawn through the lower half of the risers, however, covering the lower half nearest the commutator and leaving the top half open will greatly reduce the amount of dust drawn in without greatly interfering with the ventilation.

Brentford, England. W. E. WARNER.

## Washing a Horizontal Tubular Boiler

I HAVE READ R. F. Leach's letter on p. 764 of the July 1 issue. My opinion is that he is mistaken when he states that spraying kerosene oil under 60 lb. press. over the internal surface of a comparatively warm steam boiler is not dangerous if reasonable precautions are taken. Such a process will be dangerous unless extraordinary precautions are taken.

Such liquids as kerosene or gasoline that vaporize under a fairly low temperature are extremely dangerous when used as a spray in warm locations; the accidental breaking of an electric light bulb, the lighting of a match, or any other spark of fire in such a mixture of oil spray and warm air are liable to cause serious explosions.

In some locations, the use by painters of varnish and paint spraying apparatus in private homes and other closed buildings is forbidden. Of course such a spray could be used if every possible care were taken, but many men are careless, despite all safety first cautions.

Bricked-in return tubular steam boilers will remain warm for two or more days from the heat retained in the side and back walls. Anyone who has entered a warm boiler in which kerosene has been used will realize that he would almost require the use of a gas mask to permit working there.

There are safe methods available for preventing or removing steam boiler scale, so why use a method that may be dangerous?

Mr. Leach states that the boiler is taken out of service and allowed to stand with water in it until it has entirely cooled. If he means cooled to the same temperature as the boiler room air, this would mean that the boiler remained out of service for about 48 hr. before the cleaning out process is started. It is seldom permissible to allow a boiler to remain out of service for any extended length of time. Usually the fire is drawn after supper and the boiler cleaned out after breakfast the next day. To the person inclined to use Mr. Leach's method, my advice is to use not only reasonable precautions but every possible precaution to avoid danger of a kerosene vapor and air mixture explosion.

Uffington, Ont., Canada. JOHN THORN.

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BASE LOAD plants are usually built to operate with high pressure, high temperature, steam extraction, low vacuum, air preheaters and economizers in order to obtain high efficiency.

# Questions and Answers

## Water Circulation in a Hot Water Tank

WILL YOU BE kind enough to give me the correct method of connecting piping to a hot water boiler as shown in sketch? The tank is in the lower basement with its top at a level with the heating coil in a stove in the sub-basement. An electric heating coil is installed at the base of the tank as shown.

From a blueprint which I have seen, the inlet pipes at the top extend into the tank about 4 in. only. An inlet on the side 17 in. above the bottom of the tank has a cap over it. The hot water from the stove coil heats the tank only about 18 in. below the top of tank when stove alone is operating.

Would it improve the heating of the water to run a pipe from the stove heater direct to the side inlet, which is 3 ft. 9 in. below the stove heater line, as shown by the dotted lines? My desire is to heat the full boiler of water from the stove when in operation without using the electric heater. G. W.

A. Referring to the sketch, Fig. 1, which you enclosed, we believe your trouble is due to lack of head.

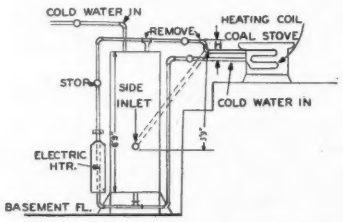


FIG. 1. INCORRECT CONNECTION OF HEATER SHOWING SMALL HEAD, H, WHICH CAUSES CIRCULATION

Flow, in a hot water tank heated as you have outlined, is due to the difference in weight of columns of hot and cold water of a height between the cold water intake and the hot water discharge to the tank, which, as you have arranged it, is equal only to the distance from the under side of the cold water pipe entering your stove to the top of the hot water pipe over the tank. The higher this column, the faster will be the circulation and the more completely will the tank be heated, since heated water rises and therefore only that portion of the tank above the level of the coil intake pipe from the heater will be heated.

You will note that the electric heater is placed as low down as possible. Gas heaters, when used, are also placed in this position. If you wish to attach your stove properly, it should be placed in a position corresponding to that of the electric heater, in which case your head would be from the bottom of the cold water intake to the top of the hot water discharge to the tank, which in this case is many times your present head when using the coal stove alone.

Connecting the hot water pipe with the side inlet will be no help and would result in heating the water in the tank only slightly while discharge in the top of the tank at least localizes the hot water in the top of the tank.

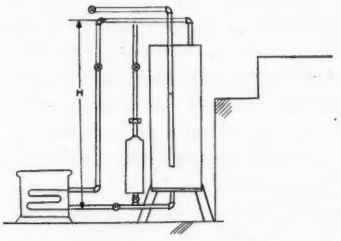


FIG. 2. CORRECT CONNECTION OF HEATER SHOWING MUCH LARGER HEAD, H, AND RESULTING IN THOROUGH HEATING OF TANK

In order to operate as you wish, therefore, the stove should be placed on the basement floor and connected to the piping by bypassing around the electric heater.

## Clean and Drain Boilers to Be Shut Down

IN SHUTTING DOWN a steel or cast-iron heating boiler for the summer, would you recommend draining the boiler or leave it filled with water? Would it be best to open the damper or choke it off? F. M. R.

A. In considering the question of how best to leave a heating boiler when shutting down over the summer, the atmospheric condition and the kind of water used in the particular location have something to do with the decision as to whether to empty the boiler or keep it full. If the humidity is high, it would probably be better to keep the boiler full of water but, if the humidity is normal or low, it is better to empty it. If a large amount of sediment is deposited when standing cold, an empty boiler is to be favored.

If the boiler is to be filled, precautions should be taken that it is kept full, so that as small amount of damp surface is exposed to air current as possible. Generally it is best to keep the boiler empty during the summer but, in this case, just before shutting down and emptying the boiler it should be heated so that, after blowing down, the boiler will still be hot enough to dry out thoroughly.

In either case, particularly when the boiler is to be kept dry, it should be cleaned all over, inside and out and then thoroughly washed with clean water before the final heating and discharge of water is accomplished.

Usually it is better to keep the draft open, also the fire and ashpit doors so as to permit free circulation

of air. In any case, all ash and soot should be carefully cleaned out of the boiler. Ash may contain sulphur and, if it absorbs moisture, this would form sulphuric acid which would rapidly corrode surfaces of iron. It is essential, therefore, that the parts be kept dry.

## Evaporative Capacity of a Boiler

How MANY POUNDS of water should a 1000-hp. boiler evaporate per hour, the feedwater temperature being 208 deg. F.? H. G. K.

A. You do not state the temperature of the steam generated. We are assuming this steam to be generated at 212 deg. and that it is dry and saturated. A boiler hp. is defined as the equivalent evaporation of 34.5 lb. of water from and at 212 deg. per hr. The amount of water evaporated from and at 212 deg. for your boiler will then be $34.5 \times 1000 = 34{,}500$.

The factor of evaporation is $= (H - h) \div 970.4$ where H = total heat in 1 lb. of steam at boiler pressure and steam temperature,

h = heat of the liquid at feed temperature,

970.4 = latent heat of evaporation of 1 lb. of steam at 212 deg.

Values of H and h are obtained from steam tables and the factor of evaporation, which is the ratio of the heat required to generate 1 lb. of steam under actual conditions to that required to generate 1 lb. of steam "from and at 212 deg.," then becomes:

$$(1150.4 - 175.98) \div 970.4 = 1.08$$

That is, it takes the same amount of heat to evaporate 1.08 lb. of water from feedwater at 212 deg. to dry and saturated steam at atmospheric pressure as it does to evaporate 1 lb. of water from a temperature of 208 deg. to dry and saturated steam at boiler pressure.

Hence, the actual evaporation to be expected will be $34{,}500 \div 1.08 = 31{,}944$ lb. water per hr. for normal evaporation under the conditions stated.

## Force Required to Stop Descending Elevator

I HAVE JUST BEEN discussing the elevator problem, printed on page 267 of the February 15 issue, with the electrician who has charge of our elevators and we believe that although your calculations are correct, you did not finish the problem so as to make it clear. The electrician did not think that it would take 1400 lb. pull to stop the elevator; that is, he was considering external force only, while you figured total force, 1000 lb. of which was supplied by the counterweight. Using the same figures, you have

$$F = m\,a \qquad \text{where } m = \frac{w}{g}$$

and the force F in this case is C — E which is 1000 lb. which if the elevator was moving downward would tend to stop it. The mass is $(E + C) \div g$, as you have figured, so that the natural deceleration of the elevator is $a = (C - E) \div (C + E) \times g = 1000 \div 6000 \times 32.2 = 5.44$ and if the initial velocity is 7.5 ft. per second the ear would naturally come to a stop in $7.5 \div 5.44 = 1.58$ sec.

Of course it will take but a small additional force to bring it to a stop in one second. This force can be calculated easily and is, as you found, $F = 6000 \div 32.2 \times 7.5 = 1400$ lb.; if this 1400 lb. is divided up into its two parts, that is, the $F_I$ of 1000 lb. due to the counterweight and $F_E$ the external force, this external force $F_E$ is of course

$$F - F_I = F_E$$
$$1400 - 1000 = 400$$

which must be applied as a brake. It could also be calculated directly because the stopping is the sum of two accelerations. Accelerations can be added directly; for instance if the car as in the sketch is accelerating at 1 ft. per sec. per sec. and a boy on a bicycle starts at the same time and also accelerates in relation to the car at 1 ft. per sec. per sec. his total acceleration with respect to A is evidently the sum of both or 2 ft. per sec. per sec. so

$$A_I + A_E = F_I \div 6000 \times 32.2 + (F_E \div 6000) \times 32.2 = 7.5$$
$$= 1000 \div 6000 \times 32.2 + F_E \div 6000 \times 32.2 = 7.5$$
$$F_E = 400 \text{ lb.}$$

The effect of gravity in helping the car stop is made clearer if each step is taken separately.

If E were dropping at an acceleration 7.5 ft. per sec. per sec., the force required to stop it in one second would be

$$F = 2500 \div 32.2 \times 7.5 = 585 \text{ lb.}$$

and so the total tension in the rope at B would be 2500 required to support the elevator and the additional 585 for deceleration or 3085 lb. which would pull upward. At the same time, C would be going up and the reduction in force required to stop it in one second would be

$$F = 3500 \div 32.2 \times 7.5 = 815 \text{ lb.}$$

This force would have to act downward so that the total force at C would have to be $3500 - 815 = 2685$. If we call deceleration downward + and upward — the net effect would be with the two of them added algebraically.

$+ 3085 - 2685 = 400$ lb. which would have to be applied externally. If both were at rest and then accelerated to 7.5 ft. per sec. in one second, conditions would be the same. With an upward pull of 3085 lb. at B there would be an upward unbalanced force of $3085 - 2500 = 585$ lb. accelerating the elevator. With a pull of only 2685 lb. at C, the downward pull due to gravity would be $3500 - 2685 = 815$ and the total force would be $815 + 585 = 1400$ lb. but only 400 lb. would be applied externally, 1000 lb. being supplied by the counterweight.

Brooklyn, N. Y. PAUL F. ROGERS.

Editor's Note: The question is repeated: "If an electric elevator of the traction sheave type, weighing 2500 lb., over counterweighted 40 per cent and traveling 450 ft. per min., is suddenly brought to a stop, what is the pressure or stress produced?"

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IN GERMANY, the Charlottenburg station is installing 16 vertical steam accumulators each unit measuring 69 ft. high, 14 ft. 9 in. in diameter with a capacity of 11,000 cu. ft. They are designed to carry a peak load of 40,000 kw. They will stand in the open with no housing.

# Editorial Comment

## Boiler Furnaces—How Much Cooling?

While moderate combustion rates and furnace temperatures were the usual condition, little trouble was experienced with destruction of furnace walls and grates. As combustion rates increased, temperatures rose. Smoke was reduced but walls and grates suffered. With the high outputs now common, and high temperatures of stoker, pulverized coal and oil burning furnaces, the necessity has arisen of devising furnace walls which will not disappear up the stack or descend into the ashpit. Air cooling and water cooling have been developed to the point where furnaces completely surrounded by cooled walls are common practice, which not only saves the walls but utilizes radiant heat that, otherwise, would be dissipated.

In cooling the furnace, the problem has arisen of keeping its temperature above that needed for combustion, since smoke will follow too great reduction. So the question becomes, how to save the walls yet avoid smoke. How much cooling is permissible or advisable?

Analyzing the conditions, R. J. S. Pigott has pointed out that completely-cooled furnaces as small as 3 ft. diam. have long been used in Scotch boilers and locomotives. They will smoke if mishandled but need not. He states also that the cooling effect of a "cold" surface extends only 2 to 4 ft. from that surface, hence the interior temperature of a large furnace is not affected. This seems to give as the answer to the question, keeping combustion at 3 ft. or so from the cooled walls, using such air volumes and turbulence as will ensure quick combustion and building walls which will absorb and carry away heat quickly while standing up against high temperature and abrasion.

Reduced to practice, this seems to indicate sufficient air admitted with the fuel and violent agitation so as to give short flame burning; water-cooled walls with such protection of tubes as is needed to prevent abrasion; clean surfaces and good circulation in the water-screen tubes, which involves low concentration in feedwater and proper design to give ample circulation area in tubes and in header connections; provision for removing ash frequently either by keeping it liquid until it is tapped from the furnace or by cooling the fly ash below slagging temperature so that it will deposit in granular form and can be removed dry; careful operating routine which will maintain in the furnace the conditions for which it was designed.

Practice seems trending in this direction and experience in various stations indicates that it is feasible to secure satisfactory operation. As in most successes, intelligent vigilance is the price to be paid.

For stoker-fired furnaces, conditions are less severe and it is probable that partial water-cooling will be found effective but, for such surfaces as are to be water-cooled, the same requirements will obtain and, the cooler the walls can be kept, the more will the expense of upkeep be reduced.

## The Total Cost of Power

"After all, operating data mean little. The day has passed when we hunt down every B.t.u. It's the total cost per kilowatt-hour that we are interested in here."

Periodically that gem is discovered by enterprising engineers browsing through the engineer's primer and modestly brought forth as an original and homely bit of philosophy. Sometimes it runs like this:

"After all, first costs measure little. With base load and high fuel costs, you can afford to spend more for high efficiencies. It's the total cost per kilowatt-hour that we are interested in here," or "After all, operating and maintenance costs mean little. Too much depends upon local conditions. Fuel and load mean too much. It's the total cost of power per kilowatt-hour that we are interested in here."

Fortunately the entire engineering profession seems to be agreed at last that the total cost of power per kilowatt-hour is, in the end, the important factor. Previous to the discovery of this great truth, which we may call the first law of power engineering, it seems that there were three schools: 1st, those who aspired to the lowest B.t.u. rate per kilowatt-hour; 2d, those who aspired to the lowest construction cost per kilowatt of capacity; and 3d, those poor unfortunates who operate the plants, who aspired to the record for low operating costs.

This, it seems, was more or less a sporting proposition with those financially interested in backing their favorite engineers, much as they would have competed in any friendly game from the side lines.

Naturally, in a country where power plants are so numerous, many candidates for the three available records were doomed to disappointment. Some disgruntled candidate, hard pushed by his backers for an alibi, came back with, "It's the total cost of power per kilowatt hour in which we are interested."

This came into wide use as one of the most impressive "sour grape" expressions ever coined. Immediately the morale of power plant designers rose. They could now openly design plants for the lowest cost per kilowatt-hour. If, in the process, they happened to make a record of fuel economy, investment or operating expense, they could boast of it; if not, they could modestly retire behind the invincible alibi, "It's the total cost of power per kilowatt hour in which we are interested."

Just what would happen if, by a master stroke, someone should achieve all three records at the same time is problematical. Possibly all information would be withheld by the second somewhat motheaten excuse of public utility executives. "We have nothing to hide of course, but publication of cost or operating data might cause trouble or misunderstanding with the rate commission," thus bringing in the one point which has not been satisfactorily answered. If the rate structure

is justly and honestly built and maintained, why should publication of data which is supposed to be available to the various commissions change the situation?

But to get back to the engineers. It is hard to understand why, if B.t.u. rates, costs and expenses have no meaning, so many engineers had an interesting time a couple of years ago explaining why their plants did not or could not be made to equal the 12,500 B.t.u. rate achieved by Mr. De Forest at Columbia. Or again, why was there such a rush of discussion trying to justify the first cost of certain individual plants following Mr. Brydon's A. S. M. E. paper a few months ago when he quite politely but firmly insisted that high pressures and complicated heat balances are difficult to justify. It has even been rumored that following the pulverization costs presented by Mr. Tenney at Cleveland last fall, some embarrassment was suffered by several engineers when asked to explain why they could not equal these costs.

Naturally, taken by themselves, records or costs of any kind mean little. With a 12,500-kw. low-pressure installation, a rate of 22,000 B.t.u. per kilowatt-hour may be as good relatively as 16,000 or even 12,500 in a larger, high-pressure station. The rate itself more or less classifies the plant as to size and type. No one would be likely to confuse in his own mind the probable layout of two stations with rates of 22,000 and 12,500 B.t.u.

After all, data of any kind are of little value unless considered in relation to the various factors which influence them. Why some engineers feel that they are the only ones with knowledge enough to appreciate these factors or why they are the only ones in the industry who realize that the total cost of power per kilowatt hour is the important factor is obscure but one may venture a guess that it is simply a bold front displayed to avoid the necessity of admitting that there are no operating data or costs of which they can boast.

## The Battle of the Smoke Stacks

With this vivid phrase, James L. Madden, vice-president of the Metropolitan Life Insurance Co., speaking at the 52nd Annual N. E. L. A. convention, characterized the competition among cities for new industries. He then presented the results of an investigation that has elicited some definite information on why, how and where industry is growing or moving. Although the facts revealed by this investigation are of great importance and value in themselves, the most important thing seems to be the fact that the investigation has been made and that the results obtained and the procedure followed can be used as the foundation for the establishment of a continuous and well worth-while body of records on this vital subject. This procedure was suggested by Mr. Madden in concluding his paper and it seems the right and logical thing to do.

The investigation was undertaken several months ago by the Metropolitan Life Insurance Co. at the invitation of the N. E. L. A. The results of the survey present a picture somewhat different from the one that was believed to exist. It has been known, of course, that many industries have been erecting manufacturing plants in the smaller cities and towns all over the country and there has been a general feeling that industry was "migrating" from the larger cities.

This survey shows, however, that, of the new plants erected in 1926 and 1927 in 2084 communities, relocations accounted for only 9.4 per cent of the plants gained, while new industries accounted for 81.8 per cent of the gain and branch plants for 8.8 per cent.

During the period surveyed, 5908 plants were lost to American cities, about 18 per cent of them moving away and 82 per cent going out of business. Number of plants lost was about 60 per cent of those gained.

Thus it is apparent that not migration of industries but rather expansion of industry as a whole has been responsible for the location of new plants in the smaller cities. Of course, there has been some actual moving of industries—the textile industry's movement southward, for example—but on the whole, migration of industry is being relegated to a smaller role in economic growth than was expected.

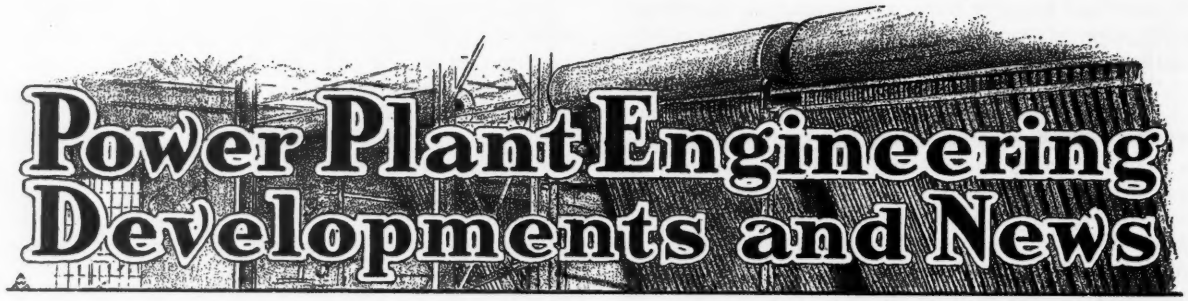
Influence of better transportation and widespread power distribution has also been marked. Lower manufacturing costs are often possible in smaller cities because living costs of employes are lower and living conditions better. In selecting a small city as the location of a new plant, therefore, a manufacturer is seldom hampered, as he used to be, by inability to transport his raw materials and his product or by the difficulty of securing the necessary power.

In the case of power, also, the question of whether the industry is to make or buy its power has less influence on plant location than it formerly did. If the plant is to make its own power, it can usually find a supply of fuel at reasonable price and from a convenient source; then engineers can design a power plant to utilize that fuel.

Accessibility to markets has also assumed an important role in locating plants and accessibility to raw material must always be considered. Even the personal desires of the owners of a company to live and work in a certain section of the country have been known to influence plant location. The survey indicated, however, that the factors most strongly influencing plant location were as follows, in the order of importance: markets, labor, transportation. Strangely enough, in this survey, the inducements of bonuses, free taxes, land, free buildings sometimes offered by cities to attract industries, were not given as reasons for location of plants.

In concluding his discussion, Mr. Madden pointed out that "there is a definite need for the present pioneering effort (of securing data on the growth of industry) to be continued on a systematic basis. Development and movement of industry so affects our social and economic growth that some machinery is necessary to record what is taking place, yet no such machinery is in existence. It would seem that a neutral agency, such as the United States Department of Commerce, would be the logical body to carry on continuously this effort to know, at all times, how, why and where industry is growing or moving."

Inasmuch as the above survey was carried out in 2084 communities, representing 75 per cent of the total urban population of the United States and about 66 per cent of the urban population of Canada, it seems that the ground-work for carrying it on is well laid. If the Department of Commerce or some other neutral and permanent agency can undertake this work, a notable service will be rendered to American industry.




# A. S. M. E. Discusses Problems of Mountain States

SEMI-ANNUAL MEETING HELD AT SALT LAKE CITY, JULY 1 TO 4, WAS DEVOTED TO HANDLING ORE, INSTALLING HYDROELECTRIC UNITS AND SMOKE PREVENTION

TO MOST of the 250 men and women who attended the semi-annual meeting of the American Society of Mechanical Engineers held in Salt Lake City, Utah, July 1 to 4, the occasion was one for getting acquainted with the Rocky Mountain states, their scenic beauty, industrial conditions and problems and their summer climate. For the convenience of attendants from eastern states, a special all-compartment train was engaged and those taking advantage of this arrangement were entertained at cities enroute and took time to visit the Rocky Mountain National Parks in Colorado, Zion Park, Bryce Canyon and Cedar Breaks in Utah, North Rim of the Grand Canyon in Arizona, Yellowstone National Park and Glacier Park in Montana.

At the technical sessions held in the Hotel Utah, the papers read and discussed dealt principally with problems encountered in that section of the country, the entire list being: Recent Developments in Air Transport by Philip G. Johnson, President, Boeing Air Transport, Inc.; Modern Practice in the Installation and Starting of Hydroelectric Units by Charles V. Foulds, Manager, Engineering and Operation, The Pelton Water Wheel Co., San Francisco, Cal.; Ore Handling at the Utah Copper Company's Mine and Mills, by H. C. Goodrich, Chief Engineer, Utah Copper Co., Salt Lake City, Utah; Recent Developments in the Mechanical Loading of Coal Mine Cars by O. G. Sharrer, Assistant Mine Superintendent, Union Pacific Coal Co., Superior, Wyo.; Salt Lake City's Fuel and Smoke Problem by Geo. A. Orrok, Consulting Engineer, New York, N. Y. and W. H. Trask, Jr., Mechanical Engineer, The Salt Lake Hardware Co., Salt Lake City.

## MODERN PRACTICE IN THE INSTALLATION AND STARTING OF HYDROELECTRIC UNITS

This paper, prepared by Charles V. Foulds of San Francisco, Calif., was read by Denison Woods. Progress in the design and construction of hydroelectric generating units during recent years has been largely in the direction of increased size and capacity, with refinement in operating characteristics and controls and with this progress there has come a corresponding development in the practices followed in the installation and starting of the increasingly complex mechanism.

Earlier machines were, as a rule, small in size and more or less self-contained and, in consequence, formed fairly rigid structures. Such machines were usually nearly if not completely assembled, with correlated parts doweled in their correct positions, in the manufacturer's works prior to shipment, frequently on one-piece baseplates, so that final installation involved little more than reassembling them on foundations with the proper connections to penstocks and other related parts.

### MODERN LARGE UNITS ARE ASSEMBLED IN THE FIELD

Development of the modern generating unit has been distinctly away from these factors that contributed to the case of correct assembly of the older ones and, in consequence, the entire technique of assembly has been changed. It is no longer possible, in many cases, to assemble in the manufacturer's works more than certain aggregations of parts of a single unit and these groups of parts are not combined into the complete hydroelectric unit until the final assembly at the time of installation. This condition applies both to the hydraulic and electrical equipment forming a hydroelectric generating unit and requires, as a rule, that much of the work done in the field shall be of a nature that would in former times have been considered shopwork.

Large generators are shipped with the frames, laminations, coils, poles and rotor segments in separate packages; these parts have at no time been assembled together in their entirety, but have simply been compared, each one with its matching part and with possibly minor partial assemblies, to make certain of the proper dimensions and fits of other related parts. In the case of the water wheel or turbine, the principal parts are practically all packed separately for final assembly, in the field. In the case of turbines, particularly those with plate-steel casings, the plates are shop-fitted, in so far as it is possible, matched with one another and then knocked down for separate shipment. Final assembly, including the riveting and calking of the joints, testing, and so on, is done only after erection.

In the case of impulse wheels, the buckets may be shipped separately from the wheels or disks and the nozzles, valves and other parts sectionalized to the greatest possible extent. Since such wheels are usually for higher-head applications, the individual parts and part assemblies can more often be completed at the manufacturer's works and the problems of distortion and final assembly do not enter to the same extent as

with reaction turbines; but in most cases, varying in degree only, there is necessity for performing in the field operations usually associated with manufacture, which require special field tools and equipment, as well as workmen who are specialists in their particular lines.

### Measures Which Will Facilitate the Accurate Erection of Large Units

To facilitate the accurate erection of large-size units, it will be found advantageous to give consideration in the design to the following principal points:

a. Provision should be made for adjustment at the inlet pipe connections to the turbine casing or nozzle body to permit the casing or nozzle to be set exactly in its proper position and level, without regard to the exact position of the penstock terminal flange, assuming that the penstock is in place prior to the mounting of the machine.

b. Grouting clearances should be provided for draft tubes, wheel-pit frames and similar parts, so that there may be a slight latitude to make up for irregularities of the parts in question or in the foundation.

c. Foundation bolts should be arranged either with grouting tubes of ample diameter to permit considerable lateral adjustment, or much better still, when conditions are favorable, cored pockets should be provided in the foundation to receive the bolts and the bolts themselves should then be hung loosely in those pockets from the parts to which they attach, the pockets being filled with grout at the time the remainder of the equipment is secured to the foundations.

d. Governor connections, both mechanical and oil-piping, should be made as flexible as possible, in order that there may be no difficulty in locating the governor in its proper relation to the machine.

e. Auxiliary piping for water or oil either should be laid out so as to provide natural flexibility through the swiveling of flanges or screwed joints, or else flanges at strategic points should be left loose for welding in place to the pipe after all of the various items of equipment are fixed.

f. The head covers of turbines and the like, where the greatest accuracy of relative location is required, should not be provided with centering fits or other restrictions to slight movements within the normal clearances of bolt holes. In cases where the greatest precision is required, portable machines may be constructed for machining in place certain of the matching surfaces vital to the absolute alinement of the important machine parts. Even where this practice is followed, some measure of adjustability is still desirable to compensate for changes that may result from aging of the parts or settlement and shrinkage of foundations.

### Support of Heavy Parts During Setting Operations

It has become general practice to provide, for the support of heavy parts, screw jacks bearing on appropriate pads at selected points of the structure; these jacks are used for the leveling of the part and are then left in place and grouted in as parts of the foundation. The location of such jacks is worked out as a part of the design with a view to correct support of the member in question and piers for their support are provided for in the design of the foundation, so that when such a large part is assembled it is not necessary for the erector to make up supports of such materials as he may find at hand. Various tension bars, struts and rings are also provided on occasion to keep the large parts in shape during the erection operations.

Steady bearings for vertical units are made with just sufficient clearance to slip over the shaft, with the expectation that the proper running clearance will be produced by scraping after erection is completed and when the true ultimate relative positions of the shaft and bearing become known for the first time, thus permitting the clearance to be uniform and securing the fullest possible bearing. The bearings of large horizontal units are fitted in the same way and with even greater reasons, for they are subject, in addition to the uncertainties of absolute shaft location, to the distortions and deflections of the shaft and bearing parts that occur under load.

### Preliminary Operations at Reduced Speed

It is common practice to operate a newly-erected unit for a period of several days at greatly reduced speed, in order to work in the bearings and get all of the various auxiliaries in proper working order before an attempt is made to run under load. In the majority of cases, this period of reduced-speed operation works in very well with the necessary period for the drying of the generator at reduced speed on a short-circuit. On the other hand, where the delivery of water to a unit may be delayed much beyond the completion of the unit itself and where the necessity exists to place the unit in service as quickly as possible after water becomes available, it is customary to dry out the generators by means of hot-air blowers and to operate the machine for the necessary running in at reduced speed by motoring it from some near-by unit.

### Salt Lake City's Fuel and Smoke Problem

This paper, presented by Geo. A. Orrok of New York, N. Y., and W. H. Trask, Jr., of Salt Lake City, Utah, sets forth the smoke and dust conditions in Salt Lake City, discussing the various plans by which an improvement might be secured. In this connection, district heat, gas firing with natural gas and coke-oven gas and the use of the products of low-temperature carbonization and the by-product coke oven were discussed and evaluated. The connection between the prosperity of Salt Lake City, the State of Utah and its coal-mining industry was indicated and certain conclusions looking toward the solution of the problem were stated.

Salt Lake City now burns over 700,000 t. of Utah coal annually and a severe smoke nuisance exists in the winter months. Winter storms may disperse the cloud for a time but the city is not free from trouble until the mountain winds start again in the spring with the warming up of the plain. While the smoke problem is the worst in winter, the dust problem from coal is also of major importance. Experiments have shown that from 1 to 3 per cent of the coal fired in furnaces of all kinds goes up the chimney into the air and household fires are even worse offenders in this respect than some industrial plants. The economic loss from smoke is not large, of the order at maximum of 1 per cent but the

dust thrown out is largely unburned coal and coke with some ash and, in some experiments, amounted to over 4 per cent of the combustible.

In large plants, most of the dust can be caught by dust catchers of various forms and well-run industrial plants with good dust-catching devices reduce this loss to less than ½ of 1 per cent. Smoke, on the other hand, is most difficult to catch; its formation must be prevented. Modern industrial furnaces are designed to do this in a measure but any high-volatile coal introduced into a hot furnace will smoke even when a most intimate mixture of air and the products of coal distillation is secured. The black, tarry vapors thus produced are persistent and most troublesome. Cleaning fires, which must be done at intervals during the day, always increases the amount of smoke and dust, although proper supervision can reduce this.

The City Council of Salt Lake has an ordinance prohibiting the production of black smoke, defined as No. 3 on the Ringelmann scale. Inspection of plants, observations from the smoke tower with telephone connections to the visible plants and active coöperation with owners and operators of plants and railways, together with the installation of stokers, have reduced the smoke from industrial sources since 1919 by 93 per cent. It is considered that 70 per cent of the smoke at present comes from household fires, with comparatively slight chances of much reduction except through a change of fuel. Leaving aside the industrial use, which is roughly 400,000 t. a year, there are 300,000 t. of coal burned by 25,000 families served by at least 50,000 chimney flues from kitchen stoves, furnaces and open grates. It is obviously impossible to exercise even a general supervision as it is dark when they are most likely to offend.

### Possible Domestic Fuels

It is with the household use of 300,000 t. that this discussion is most concerned. And here a new element has entered the problem. The Public Utilities Commission last January granted permission to the Western Public Service Corp. to lay pipe lines and import natural gas into Utah and these lines will be brought into Salt Lake, the price to the user to be 50 cents per 1000 cu. ft. for all gas used above 5000 cu. ft. per month. The use of natural gas is not absolutely non-smoke producing, since an inadequate supply of air results in the production of lampblack.

At Provo, 45 mi. south of Salt Lake City, the Columbia Steel Co. has a bank of coke ovens where it manufactures by-product coke for use in metallurgical furnace. Small-sized by-product coke, nut and stove sizes, is a most excellent household fuel for furnaces, stoves, and open grates. An additional bank of 40 ovens installed at Provo or nearer Salt Lake City would easily supply the entire domestic consumption.

The Utah Oil Refining Co., as a by-product of its business of refining petroleum, markets about 10,000 t. of oil coke per year. This petroleum coke with its 5 to 6 per cent of volatile matter and little ash content is a most excellent smokeless fuel for household purposes. Coke-oven gas (560 B.t.u. per cu. ft.) is now largely used in city gas distribution, either by itself or mixed with coal gas, water gas, or natural gas. Oil gas has a much higher B.t.u. value, does not mix as well with other forms of gas fuel and has not been so available for city gas use.

Many low-temperature-carbonization processes are in use in Europe and at least half a dozen are commercial, although few dividends have been paid. In this country no process has as yet been commercially successful, although a number have made good fuel and scientifically have been workable processes.

### District Steam Heating

Many communities noted for their freedom from the dust and smoke nuisance are served by the district steam-heating systems which have been increasing in numbers during the last few years. Freedom from smoke and dust means that every building in the community must take the steam service as well as the gas and electric service, consequently many of these steam-heating companies are run in conjunction with the gas and electric company. With the district steam system, the heating of the houses is automatically controlled, the householder being relieved of the firing and ash problem. The cost to the householder is usually from one-third to one-half higher than if he ran his own furnace, the extra cost in lieu of the firing and ash removal costs. The steam is generated at high efficiency in a large station where the smoke and dust nuisance can be nearly eliminated. Distribution costs are necessarily high, particularly if the city is spread out and the lengthening mains become more and more costly as the distance increases. Distances of 3 or 4 mi. are not prohibitive and many of the smaller industrial plants, hotels, laundries, and so on besides the householders, find such a system very attractive. The four district heating plants now operating in Salt Lake City are all in the business district, have a capacity of about 6000 hp. and serve only a small portion of the city. This service could be much further developed, to the mutual advantage of the inhabitants of the city and the steam supply company.

The conclusions drawn were:

1. That no drastic ordinance or strict enforcement of legal prohibitions of smoke can be of much help in the present circumstances.
2. That no great spending of city tax funds is indicated.
3. That, given the present smoke ordinance and a fund sufficient for vigorous enforcement in a reasonable way, the natural competition between fuels and the economic law of supply and demand will insure a reasonable solution of the problem.
4. One indicated solution under present knowledge is the by-product coke oven supplying domestic coke to householders, coke-oven gas to the gas company and increasing the use of a most valuable home product, Utah coal.

## Formation of Institute of Boiler and Radiator Manufacturers

Institute of Boiler and Radiator Manufacturers was formed on June 6, 1929, in New York City, according to a recent announcement, as successor to The National Boiler and Radiator Manufacturers' Association. The membership includes 32 companies. Colonel William J. Donovan, former assistant to the Attorney-

General of the United States, has been engaged to act as general counsel for the institute.

Following are the officers and executive committee: Chairman, H. T. Richardson; vice-chairman, Grant Pierce; secretary and treasurer, Frederick W. Herendeen; executive committee, M. J. Beirn, Grant Pierce, E. E. McNair, Max D. Rose and ex-officio, A. D. Schroth, H. T. Richardson, Frederick W. Herendeen. The secretary should be addressed at Geneva, New York. A constitution was adopted by the new institute containing a complete scheme of organization and statements of policy and code of ethics.

# A. I. E. E. Meets at Swampscott

THE 1929 Summer Convention of the A. I. E. E., meeting at beautiful Swampscott on the rock-bound coast of New England, offered for the assembled engineers both an inspiration for work and a lure to play or browse around the historic scenes in the immediate neighborhood.

About 900 were there. The Committee in charge planned well a balanced, interesting program with appeals to the technical, operating and production engineer and also provided for the comfort and pleasure of their guests, not forgetting the ladies. Full advantage was taken of the fact that nearby were many scenes of beauty and historic interest, many interesting trips to these places being arranged. Here also is the center of many manufacturing and public utility plants which gave visitors every facility to study the interesting features and methods used in these places.

On Tuesday, July 25, the convention was formally opened by President R. F. Schuchardt. The Secretary of State representing the Commonwealth of Massachusetts welcomed the engineers to the birthplace of our Nation, making special reference to the dependence of the commonwealth on industry as propelled by electricity. President Schuchardt's inspiring address on "The Engineer, Practical Idealist" made his audience feel that they were as responsible for our present civilization as the patriots of old and that the engineer had still more to do in assuring its successful continuance.

Two national prizes were presented for papers by Institute members. For the best paper on engineering practice, "Rationalization of System Voltage and Insulation," the prize was awarded to Philip Sporn. For the best paper on scientific investigation, "Extinguishing Alternating-Current Arcs," the prize was awarded to Dr. Joseph Slepian.

Results of the mail ballot were announced and President-elect Harold B. Smith, Professor of Electrical Engineering of Worcester Polytechnic Institute, was presented for a brief speech of acceptance.

Immediately following, there was a technical session on "Distribution and Power Generation" featuring a symposium on "Synchronizing at the Load" and a paper by C. F. Hirschfeld on "Rehabilitation and Rebuilding of Steam Power Plants." These and other papers at this session, to be briefed later, brought out considerable discussion, centering on the fact that the engineer must design his distribution and generating systems so as to lower the investment costs per unit of output as this is becoming the controlling feature in the cost of delivered electric energy. Paralleling this session was one devoted to problems of Electric Transportation, with four papers describing the electrification of the Mexican Railroad and typical substation practice in the United States.

Wednesday morning was devoted to two parallel sessions of technical committee reports covering many subjects and containing much material of value. The afternoon was devoted to a session on miscellaneous subjects of which a paper by F. H. Gulliksen on "A New Automatic Synchronizer" was probably of the most interest to power plant engineers. The author states that synchronizing by this method is much more reliable than the manual method.

The feature event of the Wednesday night banquet was the presentation of the Lamme Medal and the John Scott Medal to Allen Bertram Field of Manchester, England, for his mathematical and experimental investigations of eddy current losses in large slot-wound conductors in electrical machinery. This is the first award of the Lamme Medal, founded by the late B. G. Lamme of the Westinghouse Co. The proceedings of this meeting at which President Schuchardt, Professor C. F. Scott of Yale, B. A. Behrend of Boston, F. L. Hutchinson, Dr. Elihu Thomson, Charles L. Edgar and Ambrose Swasey spoke, were broadcast over one of the national radio chains.

Thursday was a day of recreation. Many took advantage of this time to go on one of the many scheduled trips. Nearly 200 took the buses to Rye Beach, Maine, where sports and entertainment were featured. It was interesting to note how many of the old timers tried out the sack races, peanut races and like sports. Vice-President Ryan won the horseshoe pitching bout. At the dinner that evening the prizes for sports were distributed. W. S. Lee, Charlotte, N. C., one of the new directors, was presented with the much coveted Mershon cup for winning the Golf Tournament.

The convention went back to work again Friday morning with two parallel sessions, one on "Electrical Machinery" and the other a "Symposium on Shielding in Electrical Measurements." Five papers were presented on progress in machine design and application. The description of a hydrogen ventilated synchronous condenser installed outdoors evoked considerable discussion. An appreciable increase in efficiency is obtained by the use of hydrogen due to lower windage losses and better conduction of heat. By Friday afternoon the general exodus began, several taking advantage of a five-day post convention tour through the White Mountains.

Many of the papers presented at this convention of interest to power engineers will be abstracted in a later issue, together with an outline of the trend of discussion at the meeting.

## Freeman Scholars Selected for 1929-1930

FOR THE THIRD consecutive year, the American Society of Civil Engineers and American Society of Mechanical Engineers have chosen recipients for the John R. Freeman Traveling Scholarships in Hydraulics.

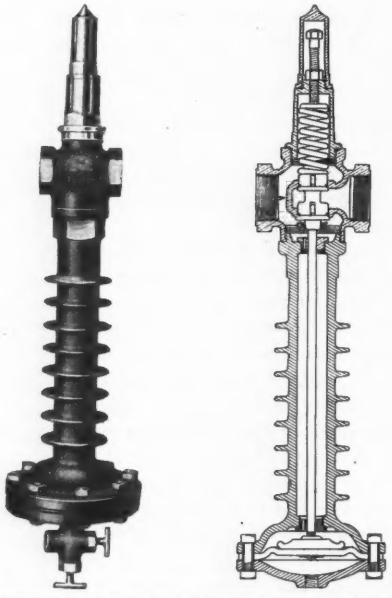
The A. S. M. E. has chosen, for its 1929-30 scholarship, Prof. Robert T. Knapp of the California Institute of Technology. The A. S. C. E. has chosen James G. Woodburn of the University of Michigan. The two

engineers thus chosen will spend a year in travel and study in Europe on the subject of hydraulics.

Previous recipients of the John R. Freeman Scholarship in Hydraulics are: Charles E. Bardsley, A. S. C. E.; Herbert N. Eaton, A. S. M. E.; F. T. Mavis, A. S. C. E.; M. P. O'Brien, A. S. C. E.; K. C. Reynolds, Boston Society of Civil Engineers; Sam Shulits, Boston Soc. of C. E.; L. G. Straub, A. S. C. E.; B. R. Van Leer, A. S. M. E.

# Packless Type Pump Regulator

ACCOMPANYING illustrations show a packless type pump regulator recently developed to maintain excess pump pressure over boiler pressure. This unit is a self-contained packless valve designed to obviate



LEFT—EXTERIOR VIEW OF REGULATOR. RIGHT—CROSS-SECTION OF REGULATOR, SHOWING DIAPHRAGM AND VALVE

any tendency to stick or bind and to operate with a minimum of friction. As shown, it has only one diaphragm connection and packings and joints have been eliminated. This regulator is a recent product of Julian d'Este Co., Boston, Mass.

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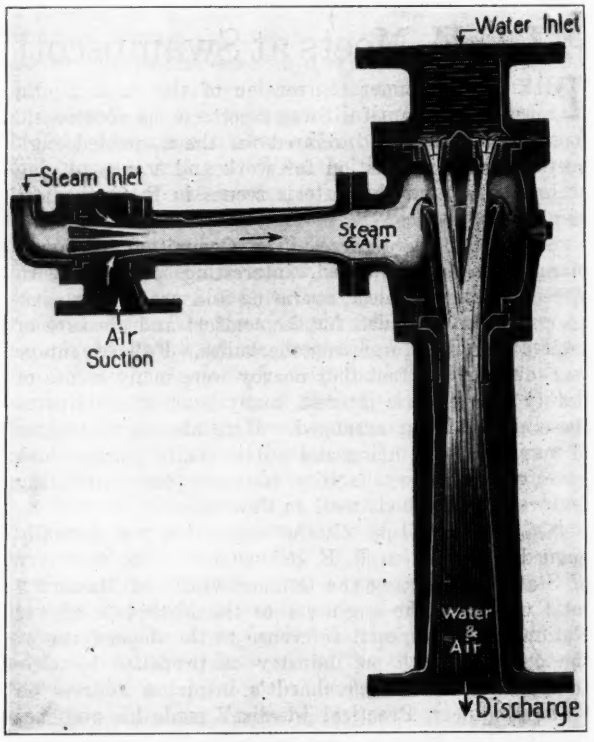
TOTAL PRODUCTION of soft coal during the week ending June 29 as announced by the Bureau of Mines, Department of Commerce, including lignite and coal coked at the mines, is estimated at 9,480,000 net tons. Compared with the output in the preceding week, this shows an increase of 402,000 t., or 4.4 per cent. Production during the week in 1928 corresponding with that of June 29 amounted to 8,444,000 t. Total production of soft coal during the present calendar year to June 29, approximately 153 working days, amounts to 253,212,000 net tons. Total production of Pennsylvania anthracite during the week ending June 29 is estimated at 1,350,000 net tons. Compared with the output in the preceding week, this shows an increase of 132,000 t., or 10.8 per cent. Production during the week in 1928 corresponding with that of June 29 amounted to 1,125,000 net tons.

# Multi-Nozzle Hydro-Steam Air Pump

FOR PRODUCING high vacuum such as is often needed in power plant and industrial work and especially for installations where air pumps are required to handle corrosive gases, the multi-nozzle hydro-steam air pump shown here has recently been developed. This is a two-stage unit, in which inter-condenser and second-stage vacuum pump are combined in one water jet machine operating on the ejector principle.




SECTION SHOWING ACTION OF STEAM, WATER AND AIR IN HYDRO-STEAM AIR PUMP

Thus it operates without inter or after condensers, the multi-nozzle steam-jet primary machine discharging as shown directly into a multi-nozzle water-jet machine designed to condense the steam and entrain the condensate and non-condensible vapors from the first state, discharging the mixture at atmospheric pressure. This discharge water, it is stated, is heated only a few degrees in condensing the exhaust from the primary stage and can be used for other condensing or cooling work. Design of the unit is such as to permit its installation at any convenient point where live steam and pressure water are available, to simplify piping and to eliminate adjustment or supervision.

These hydro-steam vacuum pumps are made by Schutte & Koerting Co., Philadelphia, Pa., in five standard sizes, with suction connections from 2 to 6 in., the capacities depending on size, steam pressure and water pressure.

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VOLUMETRIC EFFICIENCY of a pump or compressor is the actual discharge per minute divided by the theoretical displacement.

# Westinghouse Elects Merrick President

F. A. MERRICK was elected president of the Westinghouse Electric & Manufacturing Co. by the board of directors of the company at its meeting in New York City on June 26.

In announcing the election of Mr. Merrick to the presidency of the company, A. W. Robertson, chairman, also stated that the board of directors, while accepting

F. A. MERRICK

the resignation of E. M. Herr, president since 1911, in order that he might go on an extended vacation, had elected Mr. Herr vice-chairman.

Mr. Merrick advances into the position of president from the position of vice-president and general manager of the Westinghouse Electric and Manufacturing Co. He is a native of New Jersey and received his technical education at Lehigh University. Shortly after his graduation he was employed by the Steel Motors Co., a subsidiary of the Lorain Steel Co., where he was responsible for many electrical inventions and where he held the position of manager and chief engineer. He entered the Westinghouse organization when it acquired the Steel Motors Co. and in 1903 was sent to Canada to become superintendent of the Canadian Westinghouse Co., Ltd., later becoming its vice-president and general manager.

During the war he organized the operations of the New England Westinghouse Co. for the manufacture of rifles and after the war was located in London for 2 yr. as special representative of the Westinghouse Electric International Co., after which he returned to Canada to resume his duties as vice-president and general manager of the Canadian Westinghouse Co., Ltd.

In January, 1925, he was elected vice-president and general manager of the company with headquarters at East Pittsburgh, Pa.

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PRODUCTION of electric power by public utility power plants in the United States for May, 1929, according to a report of the Geological Survey, Department of the Interior, reached a total of 8,093,373,000 kw-hr., an increase of 14 per cent over that for May, 1928. Of this total, 4,608,352,000 kw-hr. were made by fuels and the remainder, 3,485,021,000 kw-hr., by water power.

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THE YALE & TOWNE MFG. CO., Stamford, Conn., announces that it has contracted to purchase the assets and goodwill of The Stuebing Cowan Co. of Cincinnati, Ohio.

# Long and Honorable Service

NEW YORK'S world-famous hotel, the Waldorf-Astoria, is being razed. The walls that echoed to the chatter of notables and society folks from the four corners of the earth have been torn down. And Ezra C. Bingham, chief engineer extraordinary, who, for 28 yr., kept the wheels of the Waldorf-Astoria running, has found another berth.

Mr. Bingham is a modest man. His headquarters were below the sidewalk level of the Waldorf-Astoria, far removed from the glitter and gaiety of the rooms above. But in his basement domain, he was general of an army of employes whose work affected every department of the great hotel. Under his sole direction for nearly three decades were the forces which made the Waldorf-Astoria practically an independent and self-sufficient community. His was the responsibility for maintaining the Waldorf-Astoria's high reputation for unfailing efficiency and comfort.

On the last days of the Waldorf-Astoria, Mr. Bingham surveyed his underground kingdom, not without

EZRA C. BINGHAM, FOR 28 YR. IN CHARGE OF THE WALDORF-ASTORIA POWER PLANT

some sadness. Here was the place where more than 100,000 pieces of laundry were washed daily. Now it was deserted. Here was the shop where 300 pieces of smashed silverware were repaired every day, with the replating plant, for gold, silver and nickel. Here was the machine shop, where lathes, drill presses and pipe-cutting machines once made a confusion of noise. Here were the carpenter shop, the tinsmith shop, the clock repair shop, the key shop. All these diversified industries had been Mr. Bingham's "job."

But these responsibilities were minor in Mr. Bingham's scheme of things. Every cube of ice that tinkled in the glasses of the upstairs dining rooms was produced under his supervision. He ran the refrigerating plant, with its capacity of 40 t. of ice and refrigeration daily, and was charged with the care of $50,000 worth of seasonable perishables. Light, heat and power systems of the hotel were under his direct control. Only once, during Mr. Bingham's long period of service, was there a failure of electric light. That was when a newspaper reporter placed a wrench across the connections in order to take a flashlight photograph of President Coolidge!

Another of Mr. Bingham's duties was to supply hot

water for the 1200 rooms, and also to make sure that the temperature of the water used in the barber shop stood at exactly 180 deg. "That would have been too hot for the rooms," Mr. Bingham remarked, "but in the barber shop, a hot towel had to be hot!"

Then there was the ventilating system, the dirt collected by the vacuum cleaning system and its disposal; supervision of the incinerators, which were kept going night and day, and of the activities of plumbers, steamfitters and decorators, helped to keep time from dragging.

In addition, was furnishing scenery and stage lighting for the many entertainments given at the Waldorf-Astoria. "All we needed was 3 hr. to prepare for the production of any stage show," he says proudly. "During all the time I have been here, we have never been in a jam through the failure of any of the machines. The machines would run as well today as on the day they were installed!"

Despite his well-filled days, Mr. Bingham found time for outside activities. He is the owner of the Post Lodge, a restaurant on the Boston Post Road, Larchmont, N. Y., and he takes a personal interest in making this restaurant one of the most popular in its section of the country. At his Larchmont home, he has monkeys, pheasants, guinea hens, geese, wild ducks, all of which he cares for himself. He is a dog lover, and likes to talk of the dogs he owns and has owned.

Although he regrets to leave the Waldorf-Astoria, Mr. Bingham is assuming an even more important position as chief engineer of the Presbyterian Medical Center in New York City, which is to be congratulated on securing such an able chief engineer.

# News Notes

THIRD NATIONAL IRON AND STEEL DIVISION of the American Society of Mechanical Engineers meeting is set for Cleveland, Ohio, September 11-13. Warner Seely, chairman of the Cleveland Section, is appointing a committee of arrangements and the technical program is planned in connection with the Iron and Steel Divisions. The meeting will be in conjunction with the National Metal Exposition and Congress which is sponsored by the American Society of Steel Treaters.

FOURTH NATIONAL MEETING of the Wood Industries Division of the American Society of Mechanical Engineers will be held in Rockford, Ill., in October at the invitation of the Tri-Cities Section of the A. S. M. E.

ANNOUNCEMENT of the First National Electrical Exposition, to be held in the Grand Central Palace, New York, October 7 to 12, under the joint auspices of the Electrical Board of Trade of New York and the New York Electric League has recently been made. Every branch of the electrical industry will be represented at the forthcoming event, it is stated. It is announced that new discoveries, developments and uses for electricity will be displayed and discussed. The Exposition will be under the management of the International Exposition Co.

SOME TRENDS IN INDUSTRY were discussed by Alfred Kauffmann, president of Link-Belt Co., in an address before the Sixth Annual Convention of the National Association of Foremen at Indianapolis, Ind., on June 8. Mr. Kauffmann first reviewed the conditions under which the average employe worked in factory or machine shop 30 yr. ago, when the prevailing spirit on the part of the management was often "Treat 'em rough and tell 'em nothing." He contrasted this attitude with the spirit of today, which, he said, is exactly the opposite; the attitude now is one of helping the workman to understand his function as one part of a complex organization and of wiping out the old barrier between white collar man and shop man.

Under modern conditions, however, regardless of the trends of business toward larger organizations and mergers, the most important factor is still the human being, said Mr. Kauffmann, and the success of any man depends on his ability to boss himself and secure intelligent and successful work from those under him.

NEW OFFICERS elected by the Stoker Manufacturers' Association at its annual meeting at the Hotel Roosevelt, New York City, are: President, Col. H. D. Savage, Combustion Engineering Corp.; vice-president, Joseph G. Worker, American Engineering Co.; treasurer, F. H. Daniels, Riley Stoker Corp. William V. McAllister was reappointed secretary. Problems of the industry were discussed and plans made for the fall meeting, which will be held at Hot Springs, Va., Nov. 11-13.

NEW MAGNETIC SWITCH, the CR-7006-D-30, is announced by the General Electric Co. to supersede the CR-7006-D-4, and is designed primarily for throwing small motors directly across the line. It can, however, be used as a primary switch for slipring motors having secondary control. It is recommended for use with small motors wherever a simple, direct control, providing complete protection to motor and operator, is required. The enclosing case is of the drawn-shell type in which plenty of room is provided for wiring. The reset button for the overload relays extends through a hole through the cover, to allow its use without removing the cover. Practically all of the parts of the switch have been improved over those of the older D-4 form. These changes include the use of a molded shaft which will not stick in the bearings, thermal overload relays with interchangeable heater units, silver contacts on the holding interlock, an E frame magnet which requires a minimum of power to operate it and restricted type blowouts. Horsepower ratings at various voltages for the standard squirrel-cage type of motor are as follows: 110 v., 7½ hp.; 220 v., 15 hp.; 440/600 v., 15 hp. For straight starting duty where no jogging is encountered, the 15-hp. rating on 440/600 v. can be increased to 20 hp.

IN THE GOLDEN JUBILEE YEAR of his connection with the electrical industry, William Symes Andrews, Edison pioneer, died at his home in Schenectady on July 1. He was the oldest employe in the organization of the General Electric Co., which recognized his service to electric lighting as unbroken from the day he entered Edison's employ at Menlo Park in the autumn of 1879, before the General Electric Co. itself came into existence. His death was directly traceable to the effects of x-ray burns sustained through a prolonged period of investigation 35 yr. ago when x-rays were so new to science that their dangerous properties in case of long exposure to them were not understood. Born at Saltford, England, September 10, 1847, he went to Toronto in 1875, and to Newark, N. J., in 1877. In 1879, he entered Edison's employ, installing the Edison lighting system in many cities. In 1894, he became manager of central station sales with the General Electric Co. at Schenectady. In 1907, he became electric lighting engineer of the company in Schenectady and Pittsfield and in 1913, was appointed a consulting engineer. He was a member of numerous engineering and scientific societies.

COPPERWELD STEEL CO. announces the establishment of a northeastern district, including all of the New England States and all of New York State north of Westchester and Rockland counties under the management of George F. Bain, with headquarters at 30 Church St., New York City. At the same office Paul Van Wagner is now district manager for Greater New York City and for New Jersey, Pennsylvania and West Virginia.

FRANCIS HODGKINSON, consulting mechanical engineer of the Westinghouse Electric & Manufacturing Co., sailed on June 8 from New York aboard the S.S. Paris for Europe, on an extended business trip. While abroad, Mr. Hodgkinson will deliver a paper on "Journal Bearing Practice" at the June meeting of the British Institute of Mechanical Engineers. He will also attend the sessions of Advisory Committee No. 5 of the International Electro-Technical Commission, of which he is a member. The sessions will be held during the early part of July in England.

TIMKEN ROLLER BEARING SERVICE AND SALES CO. announces that R. C. Brower has been promoted from general manager of that company to assistant secretary and assistant treasurer of The Timken Roller Bearing Co., Canton, Ohio. W. H. Richardson, formerly manager of the New York branch of the Service & Sales Co., has been made its general manager, with headquarters in Canton, Ohio. E. H. Austin, manager of the Kansas City branch, becomes manager of the New York branch, and L. J. Halderman, manager of the Atlanta, Ga. branch, has been made manager at Kansas City. Parker T. Ancarrow, manager of the Richmond, Va. branch, becomes manager at Atlanta and Stewart B. Ancarrow, manager of the Richmond branch.

LATEST TYPE Robins Idler, recently announced by Robins Conveying Belt Co., 15 Park Row, New York, is similar to the 203-XR Three-Pulley Timken-bearing idler, with the exception that it

has demountable pulleys. The three pulleys with their bearings and grease seals are identical and interchangeable. Each is of cast iron with totally enclosed ends to eliminate dirt pockets. Each pulley with its dead shaft of heavy seamless cold-drawn tubing can be lifted out without the use of tools except to disconnect one section of the grease line leading to the center pulley. Mounting and protection of the two ¾-in. Timken tapered roller bearings in each pulley is identical with that used for many years in the style 203-XR troughing idler. Lubrication of the six roller bearings is provided by means of grease forced through three high-pressure fittings.

NEW LINE OF COMPRESSORS, employing Timken roller bearings on the main crankshaft journals, has recently been announced by the Worthington Pump and Machinery Corp., Harrison, N. J. This is the Worthington single horizontal straight line series; capacities range from 100 to 300 c.f.m. at moderate speeds. Oil rings to deflect the surplus oil and return it to the crankcase, are mounted on the shaft beyond the Timken bearings. A special feature is the design of the crankcase enclosure; this is designed to be completely oil tight. These compressors can be furnished with ball-bearing idlers for short belt drive, with Texrope drives, or a synchronous motor may be directly mounted on the compressor crankshaft.

HOLMBERG AIR MAPPING CO. has succeeded the Aerial Photographic Service and will have offices at 132 W. Lake St., Chicago, Ill.

PLIBRICO JOINTLESS FIREBRICK CO. announces the purchase of 1200 acres of flint and bonding clay deposits, together with a completely equipped firebrick plant, in Lawrence and Scioto counties, Ohio. The town of Firebrick is located on the property. The tract is one of the properties formerly owned by the Portsmouth Refractories Co. of Portsmouth, Ohio, who have operated a firebrick plant at Firebrick for the past 25 yr. It is about 20 mi. from Portsmouth on the Ohio River.

HARTFORD STEAM BOILER Inspection & Insurance Co., Hartford, Conn., announces that J. P. Morrison, for the past 10 yr. chief inspector for its Chicago office, is to be transferred to its home office at Hartford, where, as superintendent of inspections, he will have charge of the inspection activities throughout the country. To succeed him, C. W. Zimmer, who has been his assistant, has been advanced to the position of chief inspector.

JEFFREY MFG. CO., Columbus, Ohio, announces the appointment of John L. Connors as assistant general manager of the company. Mr. Connors is a graduate of Ohio State University and Purdue University and for the past 9 yr. has been president of the Morgan-Gardner Electric Co., Chicago.

ACCORDING TO an announcement made by James A. Farrell, President of the U. S. Steel Corp. and since 1925 chairman of the Advisory Committee of the American Standards Association, 29 W. 30th St., New York, N. Y., executives representing nine of the nation's greatest industries met on July 9 at the headquarters of the American Standards Association in New York to take over from scientists and engineers the reins of direction of the national standardization movement. The occasion was the organization meeting of the first board of directors of the American Standards Association. The board of directors will include in its membership Matthew S. Sloan, president of the New York Edison Co. and affiliated electric companies; L. A. Downs, president of the Illinois Central Railroad; Bancroft Gherardi, vice president of the American Telephone and Telegraph Co.; F. E. Moskovics, president of the Improved Products Corp.; Quincy Bent, vice president of the Bethlehem Steel Co.; Howard Coonley, president of the Walworth Co.; R. J. Sullivan, vice president of the Travelers Insurance Co.; C. L. Collins, president of the Reliance Electric and Engineering Co.; Geo. K. Burgess, director of the United States Bureau of Standards.

L. H. SHINGLE & Associates have formed the Transmission Engineering Co. at Philadelphia, Pa., for the purpose of specializing in power transmission problems.

AMERICAN HOIST & DERRICK CO., St. Paul, Minn., announces the opening of a branch office and warehouse at 337 S. Anderson St., Los Angeles, Calif., in charge of W. H. Lummus. The company has appointed W. M. Cusac, formerly with the McMyler Interstate Co. of Cleveland, to its Chicago sales force.

R. H. BEAUMONT CO., Philadelphia, Pa., announces that L. H. Moule, who has been with the company for 12 yr., has been appointed sales engineer at the Philadelphia office.

MAGNETIC MFG. CO. has appointed Wells Fargo & Co., S. A., Mexico, D. F., as its exclusive representative for the Republic of Mexico with A. J. Hiern as manager.

DIAMOND POWER SPECIALTY CORP. announces that, effective July 1, it is to be represented in New York City and vicinity by its own office located at 12 E. 41st St., New York, instead of by Vincent Gilson Engineering Co. as formerly. Office personnel will consist of L. W. Nones, eastern sales manager, R. L. Townsend, H. D. Folinsbee and W. J. Fitzburges.

FREYN ENGINEERING CO., 310 S. Michigan Ave., Chicago, Ill., announces that it has been awarded the contract to design, build and erect a waste heat boiler at the Canton Works of the Timken Roller Bearing Co. This unit is of the fire tube type, designed by the Freyn Engineering Co. and is to have 5200 sq. ft. of heating surface. Steam generated at 160 lb. pressure and 150 deg. superheat will be used to augment the present plant steam supply. It will utilize the waste gases from a 100-t. open hearth furnace. Freyn Engineering Co. also announces that it has been awarded contract for the design of three waste-heat boilers by the Youngstown Sheet & Tube Co. for installation in connection with three 250-t. open hearth furnaces at the Indiana Harbor Works of the Youngstown Sheet & Tube Co. These boilers will each have 7500 sq. ft. of heating surface and will generate steam at 200 lb. pressure and 100 deg. superheat.

NEW BRANCH OFFICE of The Permutit Co. has been opened in the Montgomery Building, Spartanburg, S. C., in charge of R. V. Irwin, who for the last 6 yr. has been manager of The Permutit Co.'s office in Chattanooga.

E. H. BOLLENBACHER, mechanical and electrical engineer, for many years connected with the Westinghouse Electric & Manufacturing Co. and McClellan & Junkersfeld, Inc., New York City, has opened an office in the Forsyth Building, Atlanta, Georgia, where he has established a business as manufacturers'-Sales Agent. Among other lines, Mr. Bollenbacher will have charge of sales in the southeast of the products of The Strong-Scott Manufacturing Co., Minneapolis, Minn.

GENERAL ELECTRIC CO., Schenectady, N. Y., announces a new relay, CR-2820-1080, designed to meet the demand for a multi-finger, alternating-current device for general purposes. It is designed to be small, simple, inexpensive and to provide a large variety of contact arrangements. The relay consists of a series of double-break, silver-faced fingers operating horizontally and controlled by a small solenoid. The power consumption of the solenoid coil, it is stated, is 8 watts. The complete assembly is on a molded base over which fits a drawn shell cover. Creepage and clearance for 550-v. have been provided and it is stated that the contacts will carry 15 amp. continuously. By varying the arrangement of the contact fingers, the relay may be arranged for a number of different applications.

AUTHORITY has been granted the Illinois Power Co. to build and operate a 7,200-v. transmission line from Rochester to Berry, Buckhart and Breckenridge, dismissing at the same time the Central Illinois Public Service Co.'s application for franchise in that territory.

COMBUSTION ENGINEERING CORPORATION has made changes in its southern district offices as follows:

The former Atlanta district has been divided into three sections with offices in Charlotte, N. C., Atlanta, Ga. and New Orleans, La.

At Charlotte, T. W. Battle will be district manager with office at 919 Johnston Bldg. At Atlanta, I. S. Forde will be acting district manager with office in the Candler Bldg. At New Orleans, E. C. Walthall will be district manager with office at 1118 Union Indemnity Bldg.

UNITED STATES CIVIL SERVICE COMMISSION announces open competitive examination for mechanical engineer (mine equipment) at $3800 a year, applications for which must be on file with the commission at Washington, D. C., not later than August 14. This examination is to fill a vacancy in the Bureau of Mines, Department of Commerce, for duty at Pittsburgh, Pa., and vacancies occurring in positions requiring similar qualifications for duty in Washington, D. C., or in the field. Under only general supervision, the appointee will conduct studies and investigations, in the laboratory and in the field, of mechanical equipment and appliances used in mining, both as to safety and efficiency of operation. Competitors will be rated on education, training, experience and fitness, weighed at 70 per cent, and writings (essay, thesis, publications, or report, filed by the applicant), weighted at 30 per cent. Full information may be obtained from the commission at Washington, D. C., or the secretary of the United States Civil Service Board of Examiners at the post office or customhouse in any city.

FUSION WELDING CORP., a subsidiary of the Chicago Steel & Wire Co., has taken over the sale of all welding rod manufactured by the parent company, it is announced. The same personnel is in charge. The address is the same: 103rd St. and Torrence Ave., Chicago, Ill.

# Books and Catalogs

PHYSICAL AND MECHANICAL PROPERTIES of Portland Cements and Concretes, by W. K. Hatt and R. E. Mills, has just been issued as bulletin No. 34 by the Engineering Experiment Station, of Purdue University, Lafayette, Ind. Part I of the bulletin discusses changes of volume of cements and concretes; Part II, fatigue of mortar and concrete; Part III, extensibility of concrete; and an appendix contains a bibliography of published material on these subjects. Physical properties are tabulated, results of tests are plotted and the bulletin is well illustrated and conveniently arranged.

X-RAY PHOTOGRAPHY is usually identified in the public mind with certain phases of medical and dental science. But such a valuable tool would not readily confine itself to the needs of the anatomical sciences in this day of alertness to new uses for existing processes. X-rays are increasingly being used to determine the internal structure of inanimate objects. Steel castings, aluminum castings, metal radio transmission tubes, a variety of other metal objects, and even trees and telegraph poles, have been subjected to x-ray examination. Such examination has already become standard practice in some factories. The principal work along these lines has been done in the Watertown Arsenal and the Massachusetts Institute of Technology in the United States and in the Woolwich Arsenal in England. This information, as part of a brief survey of the theory and use of x-rays in industry, is included in a booklet just prepared by the Eastman Kodak Co., Rochester, N. Y., entitled "X-rays in Industry." The publication, which will be sent to interested persons, has the intention of suggesting some of the industrial applications of x-rays in inspecting the internal construction of opaque materials.

STANDARD SUSPENDED ROOF construction and sectionally supported side walls for all types of boiler furnaces, kilns and industrial furnaces are described in a 20-page well-illustrated bulletin issued by Standard Arch Co., Frostburg, Md. Much of the construction described in this bulletin is designed to employ 6-in. pipes on which tile are hung directly, these pipes being in turn suspended from steel work above. The design is intended to employ a minimum of steel and to require a minimum amount of head room, at the same time permitting easy and quick installation, to permit sectional support of the side walls and to allow air duct construction within the walls.

NEW METHODS for reducing the cost of erecting or remodeling industrial buildings, involving the application of modern principles of planning, cost estimating and scheduling are discussed in a recent 20-page bulletin No. 12 by Morton C. Tuttle Co., engineers, Park Square Building, Boston, Mass.

NOFUZ, Type NAB panelboard, a recent development, is described in circular D. M. F. 5150, recently issued by Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. It is designed to operate with 15-amp. deion-principle circuit breakers, as described in the July 15 issue of Power Plant Engineering, in place of fuses and toggle switches. The booklet explains the construction and use of the panelboard and its applications to hotels, hospitals and other types of installations. Working diagrams and photographs illustrate the text.

STOKER EQUIPMENT AND FURNACES is the subject of publication No. 289-71, serial report of the Prime Movers Committee for June, 1929, Engineering National Section of the National Electric Light Association, 420 Lexington Ave., New York, N. Y. During the past few years, the report states, there has been a growing tendency on the part of users of stoker fired boiler plants to increase sizes of stokers and input of coal per square foot of grate area. This has brought about the introduction of improvements in furnace construction, in methods of introducing air at the proper place and in the proper proportion for satisfactory combustion. These tendencies are in line with the real effort on the part of operating companies to reduce boiler plant costs. Statements of their experiments with stokers, furnaces, fans and air preheaters are given in the report by a number of operating companies and these are followed by manufacturers' statements regarding new types of combustion equipment and their applications. The report is well illustrated with photographs and line drawings and diagrams.

HIGH LIGHTS in the history of hospital architecture and of modern office building architecture are given in two recent bulletins issued by Jenkins Bros., 80 White St., New York, N. Y., as the first of a series covering hospitals, office buildings, schools, hotels and other structures. Bulletins are illustrated with reproductions of copper etchings.

POWER AT THE TOUCH OF A BUTTON, a recent publication No. 1842, issued by Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., describes linestarters and linestart motors and their application in modern industry.

NEW APPLICATIONS and unusual uses for Amsco manganese steel, Fahralloy and other Amsco alloys and products are described in detail in a recent bulletin by the American Manganese Steel Co., Chicago Heights, Ill.

EFFECT OF TEMPERATURE on structural steel is discussed in a bulletin sent out by the American Institute of Steel Construction, Inc., 285 Madison Ave., New York, N. Y., as the first of a technical data bulletin service for its members.

BULLETIN 8-B, describing S. & K. heavy duty steam valves, has just been issued by Schutte & Koerting Co., Philadelphia, Pa. In its 40 well-illustrated pages are contained a variety of data regarding construction details of the valves, which are made in various styles for pressures from 250 to 1500 lb. inclusive and for steam temperatures of 750 deg. F. Black and white drawings show the interior construction and method of operation of each type. Table of dimensions is also given.

BAILEY THERMO HYDRAULIC Feedwater Regulator is described in detail in bulletin 82, a 12-page, well-illustrated booklet published by Bailey Meter Co., Cleveland, Ohio. This describes, first, the operation and working principles of the regulator and then discusses the construction of the various parts. Tables of dimensions and capacities are given as well as characteristic flow curves for various types of valves.

ENGINEERING INDEX for 1928 has just been published in two volumes by the American Society of Mechanical Engineers, 29 W. 39th St., New York, N. Y. This index is a bibliography of periodical literature for the year 1928, compiled from 1700 publications.

HOMESTEAD VALVES for working pressures up to 1500 lb. and for blowoff and similar services are completely described and illustrated in a 52-page bulletin, No. 35, just published by the Homestead Valve & Mfg. Co., Corapolis, Pa. The bulletin discusses the metals used in these valves, shows interior construction and dimensions of the various types and presents data on a number of valves for special purposes in oil refinery work and other industrial applications. Remote controlled hydraulic operating valves for 1500 lb. pressure are featured, as well as Homestead protected seat hydraulic operating valves and valves equipped for alemite lubrication. The regular line of quarter-turn valves is described in considerable detail.

USEFUL INFORMATION and Miscellaneous Tables regarding pumps is the title of a 16-page booklet just issued by the Chicago Pump Co., 2300 Wolfram St., Chicago, Ill.

MCINTOSH & SEYMOUR Diesel Engines for municipal plants are described in bulletin 125, 44-page bulletin issued by McIntosh & Seymour, Auburn, N. Y. Many illustrations of actual installations of these engines in municipal plants are shown in the bulletin, together with line drawings showing plant arrangements and description of engine details.

COMPLETE LINE of gasoline, Diesel, electric and steam operated cranes, shovels and draglines are described in a 48-page book issued by Link-Belt Co., Chicago, Ill. This gives detailed specifications of the machines which have capacities from ¾ yd. to 2 yd. The book, No. 1095, is profusely illustrated with views of the equipment in operation.

TAYLOR STOKERS for Delray No. 3 Station are completely described, with illustrations of the various parts, in a 16-page bulletin sent out by the American Engineering Co., Philadelphia, Pa. These stokers are 57 tuyeres long, each with a capacity of 350,000 lb. of steam an hour continuously and nearly half a million pounds on peaks.

BOILER AND TURBINE ROOM INSTRUMENTS is the subject of publication No. 289-59, serial report for May, 1929, of Prime Movers Committee, Engineering National Section, National Electric Light Association, 420 Lexington Ave., New York, N. Y. This discusses the present trends in the use of instruments, describes instruments developed and used by member companies and results obtained with them and concludes with statements regarding recent developments by a number of manufacturers of instruments.

SUGGESTED SPECIFICATIONS for overhead line materials and methods of construction for low and medium voltage lines are discussed in publication No. 289-45 of the Overhead Systems Committee, Engineering National Section, National Electric Light Association, 420 Lexington Ave., New York, N. Y.

TYPES OF DISTRIBUTION SYSTEMS and methods of effecting changeover is the subject of publication No. 289-46, just issued by Overhead Systems Committee, National Electric Light Association, 420 Lexington Ave., New York, N. Y. This discusses types of systems and connections and applications of the various types to different classes of work.

UEHLING BAROMETER and vacuum recorder for steam turbines, designed to give the whole story of condenser performance on one chart is described in bulletin 150, issued by Uehling Instrument Co., 473 Getty Ave., Paterson, N. J.

REFRACTORIES FOR POWER PLANTS, an 8-page booklet recently issued by The Chas. Taylor Sons Co., 706 Burns St., Cincinnati, Ohio, discusses the subjects of refractoriness, shrinkage, deformation, slag erosion and spalling of firebrick and describes firebrick made by the company. In another bulletin, the company describes Tayco-x refractories for special requirements where temperatures or loads are too great for ordinary firebrick.

WESTINGHOUSE ELECTRIC & MANUFACTURING Co. announces the release of leaflet No. 1661-D which describes the new classes, 13-125 and 13-225, of magnetic starters. The starters are for use with wound rotor induction motors. The leaflet explains the construction and distinctive features of the magnetic starters. Several illustrations show the different types and accessories of the new starters.

"TYPE QS ENGINE-DRIVEN D.C. GENERATORS" is the subject of a recent leaflet released by the Westinghouse Electric and Manufacturing Co. The leaflet, No. 20414, describes the application, features, and construction of the type QS generators developed to meet the requirements of steam and internal combustion engine drives. The construction of the generators, which are available from 25 to 1500 kw. at usual voltages, two or three wire, from 100 to 450 r.p.m. is shown by means of numerous illustrations in the leaflet.

CONDENSED CATALOG OF MECHANICAL STOKERS, a 36-page illustrated bulletin, has recently been issued by the Stoker Manufacturers Association, Detroit, Mich. It illustrates and describes the construction and operation of 46 different types of stokers manufactured by members of the association. It includes data on boiler setting heights, stack diameters, stack heights, heat balance calculation, air requirements for forced draft, and so on. Copies will be sent on request to the secretary, Wm. V. McAllister, Foot of Walker St., Detroit, Mich.

BRISTOL small size recording voltmeters and ammeters, using 6-in. charts, are described in a recent folder No. 373, issued by the Bristol Co. of Waterbury, Conn.

YEOMANS' heavy-duty bilge pumps are described in an attractively illustrated 12-page bulletin B-3400, superseding bulletin B-3300, issued by Yeomans Bros. Co., 1433 Dayton St., Chicago, Ill. Tables of sizes and ratings, photographs and line drawings give details of the units, followed by a brief description of special pumps made by this organization.

METALAYER, the "putting-on tool" for building metal surfaces or preventing corrosion is described and its uses illustrated in a 48-page bulletin published by Metals Coating Co. of America, 497 N. Third St., Philadelphia, Pa.

MARQUETTE SUPER-CEMENT CONCRETE is described and its uses illustrated in a recent 24-page bulletin published by the Marquette Cement Mfg. Co., Chicago, Ill.

IN A 16-PAGE PUBLICATION No. 1831, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., describes and illustrates single helical or herringbone gears for heavy duty drives. In circular 1838, Type E flexible couplings are completely described and illustrated. The company is also issuing a new 20-page booklet C-1579-F, describing Micarta silent gears and pinions.

MAGNETIC SEPARATION for flour, feed, pulverized coal, lime, gypsum and other materials is discussed in a new bulletin, No. 90, recently issued by the Magnetic Mfg. Co., Milwaukee, Wis.

CALYX DRILLS for core drilling to determine character, order, thickness and extent of materials below or above the earth's surface, by means of cylindrical cores extracted by the drills, are described in a well-illustrated 48-page bulletin just issued by Ingersoll-Rand Co., 11 Broadway, New York. The bulletin shows by text and copious illustrations the construction of drills and driving machinery and the ways in which they are used in testing for foundation dams, buildings, bridges and many other engineering structures as well as in mining and quarrying.

WATER WHEELS for vertical direct connected installations using the submerged gate operating mechanism, are described in a leaflet sent out by The James Leffel & Co., Springfield, Ohio. The leaflet describes the various parts of the water wheels, bearings and gate mechanism, and the methods of operation, and method of setting the wheels are clearly illustrated.

LOW-PRESSURE type rotary positive blowers for any capacity at pressures of 2½ lb. or less, are described in bulletin No. 22-B1, a 16-page, well illustrated booklet just issued by The P. H. & F. M. Roots Co., Connersville, Ind. The bulletin covers the new blowers equipped with Timken, SKF and Hyatt bearings. A dimension print, table of sizes giving speeds, capacities and horsepowers at various pressures and a review of various types of pumping units are included. This bulletin replaces former bulletin 1011 of this company.

THE STRATTON VERTICAL JET FURNACE, for use with steam boilers, designed to burn crushed bituminous coal in suspension, is described and illustrated in a recent 16-page bulletin by Stratton Engineering Corp., 341 Madison Ave., New York. Details of the coal feeding mechanism, the throat unit and the control mechanism are given with illustrations of typical applications of the furnace and data regarding its performance.

THE FAILURE OF PLAIN and Spirally Reinforced Concrete in Compression by Frank E. Richart, Anton Brandtzaeg and Rex L. Brown, has been published as bulletin No. 190 by the University of Illinois Engineering Experiment Station, Urbana, Ill. The bulletin describes the materials and testing apparatus, gives results of tests of plain concrete columns and spirally reinforced concrete columns and diagrams plotted from the test.

PENSTOCK VALVES, publication No. 289-72, has just been issued by the Hydraulic Power Committee of the National Electric Light Association, 420 Lexington Ave., New York, N. Y. The purpose of this report is to give a brief review of current practice in the use of valves in penstocks. The investigation of the committee has been limited to the types of valves which are usually located in a closed penstock or conduit leading from an open forebay or surge chamber to the hydraulic power units of a water power plant. This definition excludes governor or pressure-operated relief valves, head gates for the control of diversion from reservoirs and streams and free discharge valves, although certain of the types considered are applicable to these uses. The material in this report has been compiled from data submitted by several operating companies and manufacturers.

WELDED VESSELS, as made by the A. O. Smith Corp. of Milwaukee, Wis., are described and illustrated in its bulletin No. 506. These vessels are of unusual size, up to 70 ft. long by 7 ft. diam. and for pressures up to 3600 lb. Bulletin 210 gives articles by L. R. Smith on the building of an automatic plant to manufacture 7000 automobile frames a day, or one every 10 sec.

THE METTLER ENTRAINED COMBUSTION OIL and Gas Burner is described and illustrated in an attractive 18-page bulletin sent out by Lee B. Mettler Co., 406 South Main St., Los Angeles, Calif. The latest development in these burners is the No. 42 Combination Gas and Oil Burning Unit and is described in detail.

AN ELEMENTARY ACCOUNT of the Pyrometric Cone Equivalent or the Softening of Refractories by Heat is given in Technical Bulletin No. 22, issued by Crescent Refractories Co., Curwensville, Pa.

GOULDS HIGH-PRESSURE Multi-Stage Centrifugal Pump for boiler feeding, general water supply, oil pipe line and refinery service handling oils and volatile liquids, is described in a recent 6-page folder by Goulds Pumps, Inc., Seneca Falls, N. Y. The pump is of the multi-stage type with opposed impellers designed for maximum total pressure of 900 lb. per sq. in. and capacities ranging from about 225 g.p.m. to about 1200 g.p.m., depending on pressure and power. Two and four-stage pumps, operate at 3540 r.p.m. Double guided stuffing-box glands are used, with alloy steel shaft, cast bronze wearing rings and horizontally split casing.

THE RILEY-LA MONT WATER WALL is described in detail and illustrated in a 16-page bulletin sent out by Riley Stoker Corp., Worcester, Mass. This shows how the La Mont water wall in which forced circulation and small tubes are used, is adapted to the cooling of furnace walls, discusses the rates of heat transfer, the matter of scale formation and the operating and structural advantages of the Riley-La Mont water wall. Illustration of the applications of the water wall are shown by line drawings.

ASH HANDLING EQUIPMENT is the title of an illustrated 48-page bulletin just published by the Frederick Engineering Co., Frederick, Md. This discusses the operation and construction of the Frederick steam jet ash conveyor and shows by photographs and drawings how it has been applied to power plant work.

THE FOLLOWING publications have recently been issued by the General Electric Co., Schenectady, N. Y.: Selsyns for remote control, bulletin GEA-722A; Type PQ Relays, GEA-970A; Induction Motor-Generator Sets, ⅞ to 35 kw., 125 or 250-v., GEA-394A; Undervoltage devices for manually and electrically operated oil circuit breakers, GEA-1105; Types DA-1, DA-2 and DA-3 Pillars for supporting meter panels and meter equipment, GEA-1138; Outdoor Station Equipment, weather proof switch houses, GEA-782A; Motor Drive for Metal-Working Machinery, GEA-1104.

KUPROX RECTIFIERS, their construction, principle of operation, electrical characteristics and advantages are discussed in detail in a series of bulletins just issued by The Kodel Electric & Mfg. Co., Cincinnati, Ohio.

GENERAL STOKERS for power and heating boilers in two types, for boilers from 75 to 250 boiler hp. capacity, are described in a six-page folder just issued by the General Stoker Corp., 270 LaFayette St., New York, N. Y.

# Power Plant Construction News

**Ala., Birmingham**—The Republic Iron & Steel Co., Youngstown, Ohio, plans complete electrification of its iron ore properties in the vicinity of Birmingham, Ala., reported to cost close to $200,000, with equipment.

**Calif., Los Angeles**—The Bates Valve Bag Co., 35 East Wacker Drive, Chicago, Ill., plans installation of power equipment in proposed branch plant at Medford and Miller Avenues, Los Angeles, entire project to cost more than $100,000. Local offices are at 2001 East Fifty-seventh Street.

**Fla., Jacksonville**—The East Coast Preserving Co., San Jose Boulevard, plans installation of power equipment in connection with a new plant unit, reported to cost about $80,000.

**Ga., Atlanta**—The Georgia Power Co., Atlanta, has awarded a general contract for steel frame superstructure for proposed new steam-operated electric power plant to the Ingalls Iron Works, Birmingham, Ala., and will place work under way at an early date. The entire project is reported to cost upward of $500,000 with equipment.

**Ill., Chicago**—The Ajax Quilting & Mfg. Co., 3424 West Thirty-first Street, plans installation of power equipment in proposed two-story addition to mill, reported to cost about $140,000. Harry Glubb, 360 North Michigan Avenue, is architect.

**Ill., Chicago**—The W. H. Salisbury Co., 401-21 Morgan Street, plans installation of power equipment in proposed new rubber goods manufacturing plant at 944-54 West Kinzie Street, entire project to cost $125,000. Albert P. Dippold, 3948 Cottage Grove Avenue, is architect.

**Ill., North Chicago**—The Construction Division, Veterans' Bureau, Washington, D. C., will receive bids until Aug. 20, for the installation of steam and electric distributing systems, and other electrical work at the United States Veterans' Hospital, North Chicago, as per plans and specifications on file.

**Ind., Indianapolis**—The Board of Works is considering a recommendation of Christ Hoffman, custodian at the City Hall, for a fund for the purchase of stokers for installation in the boiler room at the building.

**Ind., Indianapolis**—The Citizens Gas Co., 47 South Penn Street, is considering an expansion and improvement program at its plant, to include the installation of new gas compressor unit, byproducts ovens and equipment, and auxiliary apparatus for increased output, entire project to cost close to $800,000.

**La., Jennings**—The Tip Top Canal Co., is considering the rebuilding of pumping plant, recently destroyed by fire, and will install electric-operated pumping equipment and auxiliary apparatus. Jules Reaud is general manager.

**Mass., Northampton**—The Board of Trustees, Clark School for the Deaf, has authorized the immediate construction of a one-story boiler plant, 80 x 86 ft., at the institution, reported to cost close to $25,000, with equipment.

**Mass., Taunton**—The North Dighton Stove Co., Railroad Avenue, plans installation of power equipment in connection with proposed rebuilding of portion of plant recently destroyed by fire with loss reported at $100,000.

**Mich., Bay City**—The Murray Body Corporation, 1424 Aberle Street, Detroit, has plans under way for extensions and improvements in power plant at Bay City, reported to cost upward of $50,000, with equipment. Albert Kahn, Inc., Marquette Building, Detroit, is architect and engineer.

**Mich., Detroit**—The Ex-Cell-O Aircraft & Tool Corporation, 1469 East Grand Boulevard, Detroit, plans installation of power equipment, in connection with expansion and improvement program reported to cost more than $500,000.

**Neb., Fairbury**—The City Council is planning the early rebuilding of portion of municipal electric light and power plant, recently destroyed as a result of a tornado, estimated to cost about $55,000, with equipment. H. N. Smith is mechanical engineer and superintendent.

**Neb., Omaha**—The Board of Trustees, Creighton University, Twenty-fifth and California Streets, has plans under way for a new power plant at the institution to cost in excess of $100,000, with equipment. L. A. Daly, Peters Trust Building, Omaha, is architect.

**N. J., Camden**—The Wilckes-Martin-Wilckes Co., Fifteenth and Pine Streets, plans installation of power equipment in connection with proposed rebuilding of portion of lamp black and chemical plant, recently destroyed by fire with loss reported at $100,000. Headquarters are at 135 William Street, New York.

**N. J., Jersey City**—The Brunswick Laundry, 222 Tonnele Avenue, has completed plans for the construction of a one-story power house, 85x100 ft., reported to cost about $45,000, with equipment. P. Simeone & Co., Inc., 22 Journal Square, Jersey City, is engineer.

**N. J., Passaic**—The William Wilhelm Co., Inc., 51 First Street, Passaic, has filed plans for a one-story power plant at its factory, estimated to cost about $40,000, with equipment.

**N. Y., Brooklyn**—The Brownsville & East New York Hospital, Inc., 9702-30 Avenue A, is completing plans for a boiler house in connection with a mechanical laundry, entire project to cost about $35,000. E. M. Adelsohn, 26 Court Street, is architect.

**N. Y., Menands**—The J. B. Lyon Publishing Co., 70 East Forty-fifth Street, New York, plans installation of power equipment in a new printing plant on the Troy Road, Menands, entire project to cost more than $1,000,000.

**N. Y., Owego**—The Endicott-Johnson Corporation, Binghamton, N. Y., plans installation of power equipment in proposed shoe factory at Owego, entire project reported to cost more than $200,000.

**Ohio, Columbiana**—The Columbiana Water & Electric Co., Columbiana, is planning the early rebuilding of portion of power house and pumping plant, destroyed by fire, July 4, with loss reported at $25,000, including equipment.

**Ohio, Warren**—The A. M. Byers Co., Clark Building, Pittsburgh, Pa., is said to be planning the installation of power equipment in connection with a proposed expansion program at its wrought iron pipe mill in vicinity of Warren, entire project, reported to cost $750,000.

**Pa., Mount Carmel**—The Hazel Brook Coal Co., Mount Carmel, will soon begin construction of an electric-operated coal breaker at its colliery near Mount Carmel, reported to cost close to $1,000,000, with equipment.

**Pa., Philadelphia**—The American Cigar Co., 6808 Greenway Avenue, will install power equipment in proposed four-story plant addition, project to cost in excess of $200,000. Plans are being completed.

**Pa., Philadelphia**—The E. F. Griffiths Co., 346 East Walnut Lane, has plans completed for a two-story boiler plant at register factory, reported to cost close to $40,000, with equipment. The Ballinger Co., Twelfth and Chestnut Streets, are architects and engineers.

**Pa., Philadelphia**—The Hess-Bright Manufacturing Co., Front Street and Erie Avenue, plans installation equipment in proposed addition to ball bearing manufacturing plant, entire project reported to cost about $100,000.

**Texas, Dallas**—The Texas Aero Corporation, Temple, Texas, plans installation of power equipment in proposed new aircraft manufacturing plant at Dallas, entire project to cost close to $100,000. Roy Sanderford is general manager.

**Utah, Salt Lake City**—The Utah Power & Light Co., Kearns Building, will proceed with the construction of a two-story and basement addition to steam-operated electric power plant on Glendale Avenue, estimated to cost about $250,000, with equipment.

**Wis., Fulton**—The Wisconsin Power & Light Co., Madison, has approved plans for the rebuilding of its power plant at Fulton, near Edgerton, to cost close to $80,000. E. J. Kallevang is chief engineer.

**Wash., Seattle**—The Aircraft Plywood Corporation, operating at the former plant of the Gould Lumber Co., is said to be planning the installation of power equipment in a proposed new plant addition reported to cost more than $75,000. The First Securities Co. of Seattle, Lawrence M. Arnold, president, is interested in the project.